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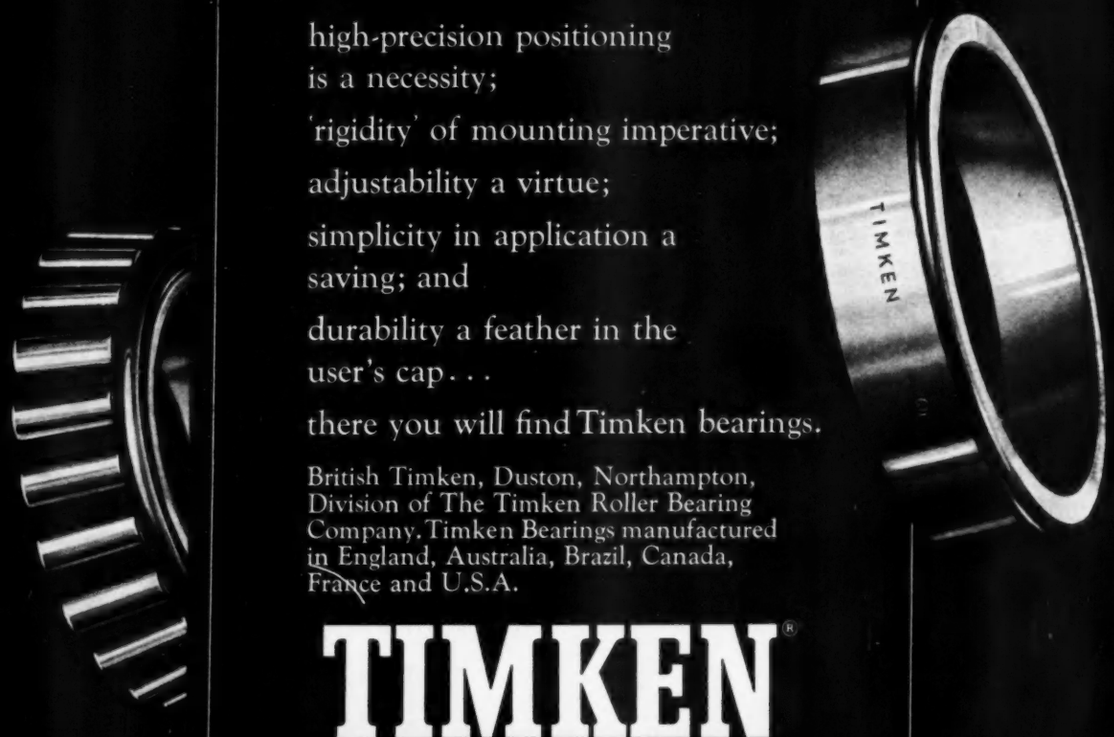

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THE ENGINEER

Established 1856

No. 5499 JUNE 16, 1961 VOL. 211

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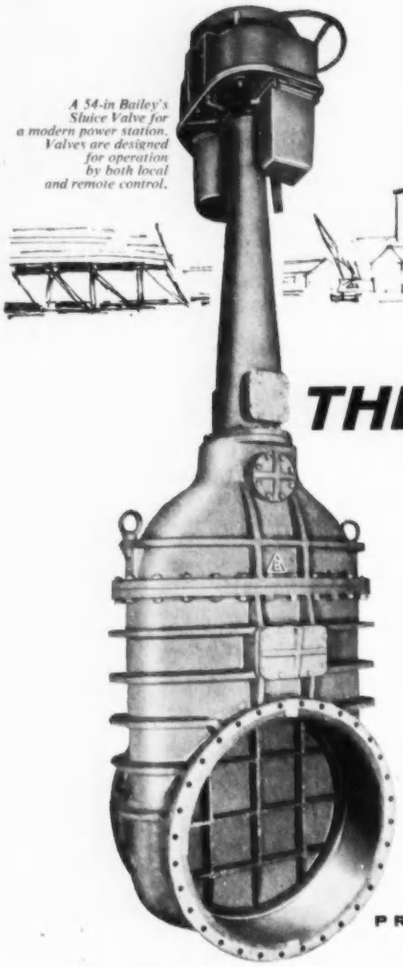

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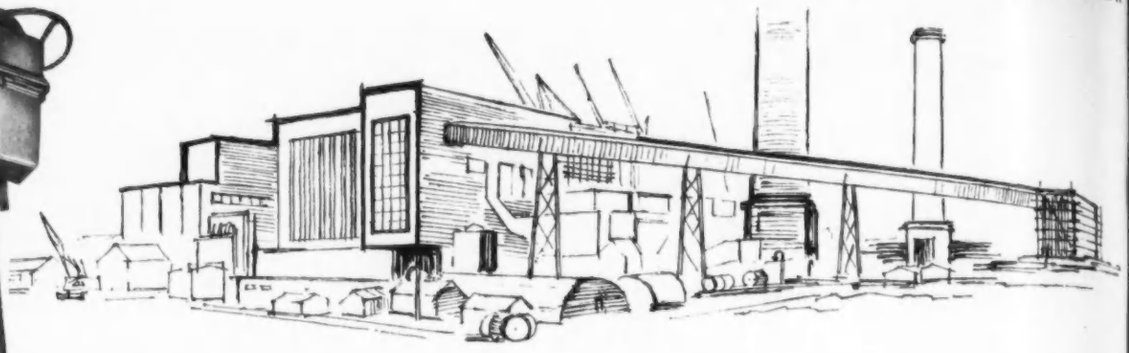

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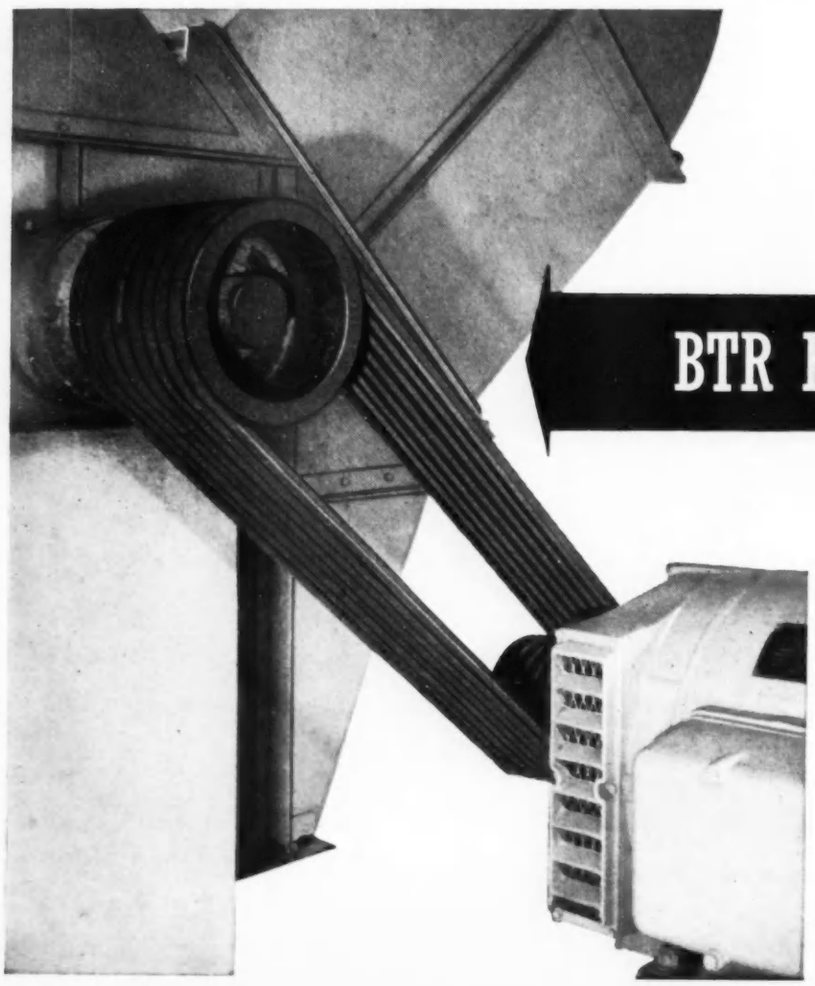

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THE ENGINEER

No. 5499 JUNE 16, 1961 Vol. 211

CONCLUSION OF A CORRESPONDENCE

It is time to bring the correspondence on "Millions to be Saved?" to an end. No more letters on that subject will be published after our next issue has appeared. But before finally closing it down we claim the editorial indulgence of having the last word. As a consequence of publishing that correspondence we have been accused in conversation of being anti-railway and of supporting the Railway Conversion League. How difficult it is, not merely to be in fact neutral, but to appear neutral to the contestants! We are not anti-railway; and we do not support the League. In the sense that we actively want them to survive we are pro-railway; and in the sense that whenever a length of railway is abandoned we hold that immediate consideration should always be given to its conversion into a road we do support the League. We are, indeed, critical of railwaymen and railway enthusiasts; but we are critical because we want the railways to survive and it seems to us that many of them far too often fail to appreciate what kind of competition it is which the railways are up against. Some, we think, do not even want to understand it; they hate emotionally to have it pointed out to them. We are strongly critical of the complacent assumption, of politicians as well as railwaymen, that the survival of railways is essential to this country. The statistical evidence, in fact, indicates that the railways are, quite rapidly, diminishing in relative importance. It follows that we are grateful to the supporters of the League for making clear such a fundamental fact as that a single lane of roadway is capable of carrying at least as many tons of freight or as many passengers an hour as a railway line even when that line is equipped with highly sophisticated signalling and, given motorway standards, carrying them as fast and as smoothly as a present-day train. Does anyone really doubt that as motorways spread across the country coaches and lorries are going to be built to take advantage of them and to travel at speeds of 50 and 60, perhaps 70 or even 80 m.p.h. along them? In a few years time, when a skeleton of motorways will already cover the country and when road access at almost motorway standards will exist to the centres of several cities, will the Railway Modernisation Plan have put the railways in a favourable position to compete with road transport? Frankly much though we would like to believe it we do not think so. On the contrary we fear that the railways (which have already become the junior partners in the transport set-up) will have become more junior still and less able to compete, not more able.

In short we think the modernisation plan urgently needs revision. In passenger carrying and in freight carrying railwaymen should surely be thinking in terms of start to stop speeds of at least 100 m.p.h. or so, so as to make up for time lost by passengers in getting to and from stations and changing at junctions; and by freight due to shunting in goods yards and due to transhipment between rail and road at terminal points. How else are they to compete with road vehicles in door-to-door speeds? How else are they to compete with aircraft for the carriage of passengers over the longer distances? Should not the railways be much more ruthless in closing down branch lines and cross-country routes? What happens if, within the next few years, it turns out that despite modernisation the railways are still failing to compete economically with the roads? Is it really possible to believe that under those circumstances the taxpayer in this small country could be bamboozled by talk about the necessity for railways into paying a subsidy very much longer? The League believes on much these grounds that the railways are necessarily doomed. We do not! But we do think that unless those responsible for planning the railways take into account the spreading of motorways across the land they will be doomed to recurrent financial losses in the future and the carrying of a lesser and lesser proportion of the country's inland freight and passengers; in which case might it not become plain financial good sense to turn some, even of the main line, routes into roadways? How many railwaymen and railway planners have travelled along M1? How many have tried to visualise what kinds of novel vehicles will be made to travel along such motorways? How many have tried to assess the carrying power of a motorway for comparison with that of a modernised main line railway? How many have been led astray in making that comparison by statistics comparing the passenger carrying capacity of a railway line with that of a roadway lane used exclusively by private cars containing only the driver or only the driver and one passenger? The correct comparison, of course, is that against a roadway lane used by thirty or forty-seater coaches specially designed for motorway conditions. The trouble is that in the context of motorways and of the modernisation plan as it stands it is not really possible to have much confidence that the fortunes of the railways will not continue to decline. Does the plan really express the best the railways can do for the amount of money to be expended? We do not think so. Let the railways go out more boldly and also more ruthlessly to challenge the real problems of the future!

NEW BROOM AT B.T.C.

By a coincidence we had hardly concluded the writing of the previous leader when it was announced that Dr. Richard Beeching, the new chairman of the British Transport Commission, was to hold a Press conference. What he had to say at that conference is abstracted elsewhere in this issue. It is, of course, far too much to expect that Dr. Beeching should already have become *au fait* with the whole problem of the railways in detail. Yet we think his first approaches will commend themselves to engineers. For he is at least able to contemplate the possibility that railways might disappear. "The railway system of the country is an asset of such potential importance and of such high replacement value that a continuing life of many years seems to be assured for it even if its ultimate replacement is planned in the meanwhile." Again he seems capable of thinking in more ruthless terms than railwaymen may care about. "Important among the steps towards quick cost savings are more rapid elimination of redundant parts of the system and also of loss making traffics." Hindsight may be easier to attain than foresight; nevertheless it is refreshing to hear said what everyone has thought likely to be true. "It is now quite clear that the modernisation plan alone will not lead to viability."

We commend to engineers also Dr. Beeching's review of the modernisation plan. He points out that there was too much optimism about the rapidity with which the improvements would benefit railway users, and too much underestimating of the effect of the disturbances to traffic due to modernisation works. "Moreover most of the major features of the modernisation programme are of such a nature that whole parts of the programme have to approach completion before appreciable cost savings or improvement in the quality of the service can be expected." There is, too, plenty of evidence of clear introductory thinking. "The main uncertainty is focused on the potential viability of the main line network . . . which carries both the bulk of the freight traffic and the middle to long distance passenger services." The expectation is expressed that passenger traffic on these lines will be maintained and possibly increased. But "unless freight traffic receipts can be considerably increased the main line system will not pay." Dr. Beeching goes on to show that of the various freight categories only that of general merchandise offers prospects of substantial expansion and that "large gains in volume are possible." He adds, "The main freight movement system on the railways, while suited to coal and minerals for which it was developed, is not suited to movements of most merchandise traffics and the development of other forms of transport have made it unacceptable to many potential users." In short, if the railways are to become viable they must prove able to compete with road vehicles in the carrying of general merchandise. Hopefully — we hope not too hopefully — he believes "large improvements in quality of service are potentially available."

In the past railway spokesmen have tended to state axiomatically that the railways are particularly well suited to carry certain traffics such as that of commuters and that of bulk goods; and there has been a tendency to overlook that road transport can carry some of these traffics at least equally well and may prove better able to carry them when motorways spread over the country. But Dr. Beeching accepts nothing as axiomatic. He is having certain studies made; of the costs, &c., of handling certain traffics; of the forms of traffic which the railways do handle or could potentially handle more cheaply than other modes of transport; and of the patterns of traffic flow by all forms of traffic in order to discover what volume of traffic favourable to rail is available and what possibilities there are of modifying the railway system of freight handling to attract the maximum amount of remunerative traffic. Dr. Beeching does not even accept it as axiomatic that railways can be made to pay. Only, he says, when such studies have been completed "shall we be able to forecast whether the railways as a whole can again become self-supporting." In fact Dr. Beeching appears to see clearly that the railways are fighting for survival. All engineers will hope that he succeeds in convincing all railwaymen upon that point. He will have to convince others, too, the Minister of Transport and the members of the Transport Tribunal among them. For some of the actions he will need to take, such as raising fares and charges, where it can be done without loss of traffic, and ruthless closing of branch lines and elimination of unremunerative traffics, are bound to prove unpopular.

MORE LIGHT ON EDUCATION

Education can prove a very dry subject. But Sir Willis Jackson, who seems hardly able to open his mouth in public without talking about education, manages somehow to make it perennially interesting. In this issue we print extracts from the 1961 Viscount Nuffield paper which Sir Willis presented before the Institution of Production Engineers last Wednesday. We count it especially valuable to be able to print those extracts at this time as they tend to correct any imbalance which may have been created by the publication of three articles on "Science and Design in Engineering Education and Practice" in our last three issues, all of which were critical of universities and colleges for their inattention to problems of design. There are also other deficiencies in methods of instructing the young! It will be noticed, for example, that Sir Willis, who, as director of Research and Education at A.E.I. (Manchester), Ltd., has had unrivalled opportunities of studying and trying to understand that product of the university, the holder of a degree, is inclined "towards a common course for all engineering undergraduates during their first and second years, with sub-divisions into civil, mechanical, electrical, chemical and aeronautical engineering deferred to the third year, and with specialisation within these branches still further deferred until the post-graduate stage." The danger that he perceives in specialisation is that "the young engineer seeks to find the solution to his technical problems in terms of his speciality." He stresses too the need to "open the mind of the student to the fact that exclusive devotion to a scientific and technical discipline will not give him all he needs in preparation for a career in engineering, and for life."

Many people will be interested to learn that at A.E.I. "the manufacturing function proves with us to be an attractive one to many of the best of our undergraduate recruits." That seems to be contrary to general experience and it suggests a presentation of the subject by the firm to the graduates under training in the works different from that usual elsewhere. The key to the firm's success is perhaps to be found in the presentation of the subject "as making intellectual demands, which are no less severe, and as requiring men of no less intellectual calibre than those of research development and design — and as affording greater scope in the field of human relations." Sir Willis also asked some pertinent

questions about the education and training of engineers. "Is there a framework of general principles and a systematic body of knowledge about industrial organisation and management which, properly presented, will guide and assist young engineers the better to assess their personal experiences in this field? Can anything be done — in courses — to develop a man's ability to recognise and appreciate the significance to his own field of work of the activities of others engaged in related fields; to organise co-operative efforts among men of whose respective specialities he may have only limited detail knowledge; to draw reliable deductions from, and make sound decisions on inadequate evidence and in insufficient time; and to represent the views of other people, as well as to express his own, clearly and concisely?" Read in one way those questions can be seen as an expression of criticism of the modern university product. Read in another way they may be seen to express the desire of the elderly to find some means of endowing the young with their own hard-won experience. Is it really true that each new generation must learn for itself by repeating the mistakes and the indiscretions of their elders?

We have always maintained on this journal that there is an essential unity in engineering which transcends all the specialisation into which engineering appears to be fragmenting. Listen to Sir Willis. "Inevitably in the early stages of his career the young engineer must become something of a specialist. Equally inevitably, however, he will become a first-class specialist only if he is knowledgeable about, and capable of appreciating the significance of, what is happening in other specialities which may come to impinge upon his own." Clearly Sir Willis thinks as we do that the best engineers are not those with the greatest specialist knowledge, but those who combine specialist knowledge with as wide and deep a general appreciation of the works of engineers as they can manage to obtain.

RATES

Anyone who knows even only a very little about the way rates are levied upon industry will certainly think that it ought to be possible to devise some other than this archaic system of raising local revenue. As Lord Ridley complained in a recent debate in the Lords', rates have come to be based not only on the value of industrial buildings but also upon the estimated values of items of production plant or upon some parts of it and not on other parts of the same plant. It is often difficult to foresee whether a particular item of new plant will or will not attract rates! No wonder there is worry about the ending of the partial derating of industry under the Rating and Valuation Bill! No wonder there is more worry in some industries than others! For incidence of valuation for rates is uneven and unpredictable and full of anomalies. Yet it seems that the system of levying rates, originally adopted because there was no other way satisfactorily of assessing ability to pay than by valuing a man's property, is so deeply rooted in this country that it cannot be changed. Industry must continue to pay up even though, as does happen in large works, it provides its own water supply, has its own fire brigade, makes its own fuel for heating and lighting and provides its own transport within and often without the works.

The incidence of rates on industry in this anomalous way is to remain unchanged; not so the incidence of rates on learned societies. There, too, heretofore, the situation has been anomalous, not to say contradictory and ridiculous. For very many years a few such societies — the Royal Society is the most distinguished among them — have been wholly derated. Others have not. Only recently, the latest of a succession of bodies to make the attempt, the Institution of Mechanical Engineers, came to the end of its long drawn-out and unsuccessful litigation to rid itself of rates. So anomalous is the present situation that it has been held that if the Royal Institution were to give away cups of tea to its members before a meeting it might lose its privileged status! Under the Rating and Valuation Bill all this is to be changed. Following a recommendation of the Pritchard Committee all suitable societies alike will be relieved of rates to the extent of 50 per cent.

Naturally deep concern has been expressed about the effects upon societies which will now become liable to pay rates. But, to be frank, as engineers our withers remain unwrung by their cries of distress. The work of the Royal Society (derated) is undoubtedly of great value to the country; so, too, is the work of the engineering societies most of which pay rates in full. Distinctions are invidious. But we must pay heed to the anguished cries of certain local authorities, notably the Westminster and Marylebone Councils within whose bounds so many of the bodies to be partially derated have their headquarters. For why should the inhabitants of those areas have to carry what is fundamentally a national burden? Fortunately, judging by some of Lord Hailsham's remarks in winding up the debate the Government has taken the point. A satisfactory way of getting round that difficulty is being sought.

The Engineer—100 Years Ago (JUNE 14, 1861).

"ANOTHER ANCIENT BRITON EXHUMED."

"Sir,—Having read with much interest your notice headed 'An Old English Locomotive in America,' with a description of the 'John Bull,' built by Robert Stephenson, it occurred to me that probably very few of your readers are aware of what has become of the 'Eclipse'—Dr. Churche's locomotive, of 1838,—the first engine, I believe, that ran the mile in a minute, and also the first tank-engine on four wheels. About four years ago I found the parts of this celebrated engine scattered about these premises; it had been purchased by the proprietor to haul coals on the line between this place and Swansea (now called the Swansea Vale Railway). On examining the parts I was astonished to find, in so old an engine, the most elaborate work; a display of the most profound ingenuity in the arrangement and construction of parts.

"The greatest care seems to have been taken to reduce the friction to a minimum, the connecting-rods being fitted with guide-wheels, one in each, which worked between the bars, the valves were also piston-valves of steel, working through brass bushes in the valve-box, which was merely a round pipe; the piston consisted of sixteen pieces (segments and wedges), of brass well-fitted, and without showing any sign of wear; also, one spiral spring of steel wire, which surrounded the centre of the piston, and which acts upon the eight wedges, which, with eight segments, form two rings, 1in in width. The reversing gear is the most elaborate I ever met with, and requires some few hours study and examination to comprehend its *modus operandi*; at the same time one is struck with the idea that the man who invented and arranged such mechanism was a person of no ordinary talent."

"F. W. Turner,
Swansea, June 10th, 1861."

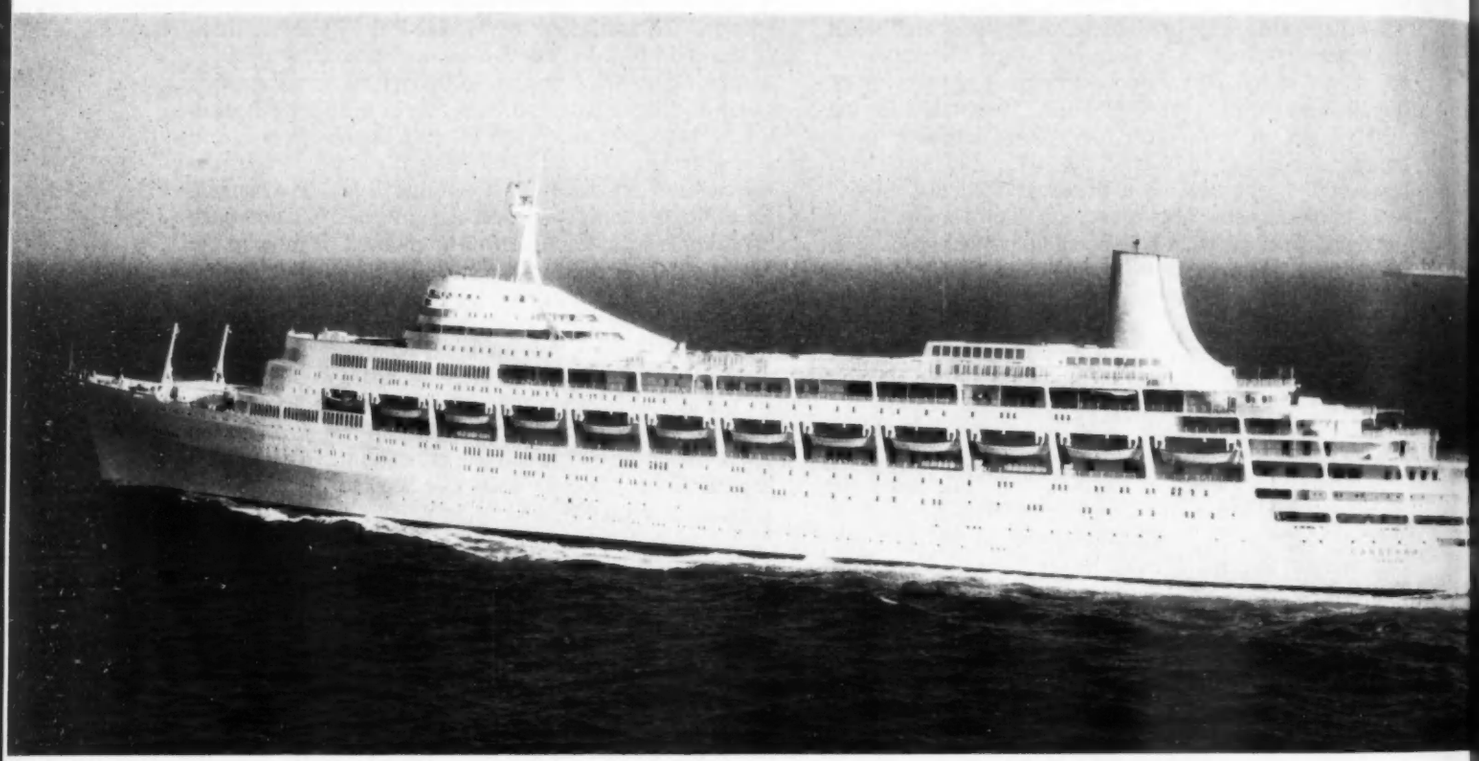
P. & O.—Orient Liner "Canberra"

No. I

The turbo-electric liner "Canberra" has been built for the Australia–trans-Pacific service of the P. & O.—Orient lines and carries 548 *first-class and* 1690 *tourist-class passengers and a crew of* 960 *at a service speed of* 27·5 *knots. The liner has a gross tonnage of* 45,270 *and a net tonnage of* 23,968 *and is propelled by twin screws, each driven by a double unit synchronous motor, power being supplied by two turbo-alternators. Normal service power developed is* 68,000 *s.h.p. and steam is supplied at* 700 *lb per square inch gauge and* 950 *deg. Fah. by three Foster Wheeler E.S.D. boilers.*

THE entry into service on June 2 of the T.E.S. "Canberra" marked the completion of a project which began with the announcement of the placing of the order for this ship in January, 1957, and continued with the laying of the keel by Harland and Wolff, Ltd., at Belfast in September of the same year and the launching ceremony performed by Dame Pattie Menzies in March, 1960. The ship, which was given the name of the capital city of Australia to symbolise the role which the P. & O. company has filled in the development of Australia's trade and overseas commerce during the last century, embodies the results of much forward thinking and the design is founded upon the basic requirements of passenger complement, cargo capacity and speed.

As for "Oriana," which is engaged in the same service linking Southampton with Australia and New Zealand via the Mediterannean and then North America across the Pacific Ocean, the design concept is the result of a careful appraisal of the many factors which had to be satisfied to meet economic considerations. Estimated passenger miles had to be translated into accommodation space and ancillary services, and time in port in relation to cargo capacity while port to port runs determined the speed required. Consideration of these basic factors in association with technical requirements, as governed by speed/length ratio and stability, &c., together with capital cost, operational costs and potential earning power determined the final dimensions and form of propulsion which are recorded in a tabular statement.



P. & O.—Orient passenger liner for service from Southampton to Australia and the west coast of North America

MAIN PARTICULARS

Length overall	818ft 3in
Length between perpendiculars	740ft
Breadth moulded	102ft
Depth moulded to "E" deck	41ft 6in
Draught loaded	32ft 6in
Service speed	27·5 knots
Gross tonnage	45,270
Net tonnage	23,968

Accommodation

First class passengers	548
Tourist class passengers	1690
Crew	960

Propelling Machinery

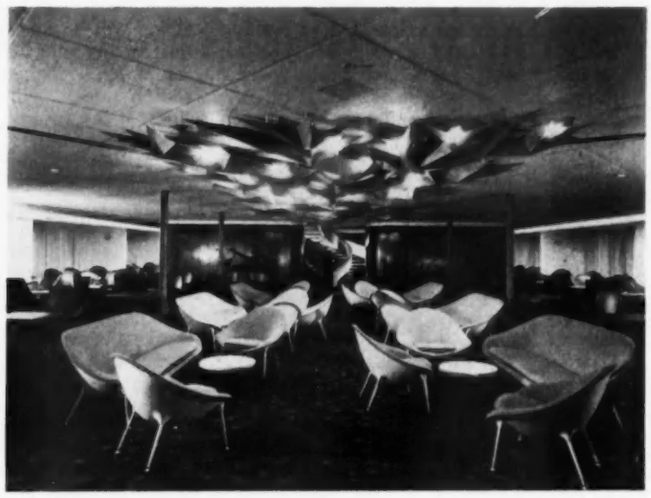
Twin screw turbo-electric	
Two double-unit synchronous motors	
Normal service power	68,000 s.h.p. at 137·5 r.p.m.
Maximum power	85,000 s.h.p. at 147 r.p.m.
Turbo-alternators	Two
Maximum rating	32,200kVA, 6000V, 3087 r.p.m.
Normal service rating	25,800kVA, 5600V, 2867 r.p.m.
Boilers	Three main and one auxiliary Foster-Wheeler with external superheaters
Steam supply	750 lb per square inch gauge at 960 deg. Fah.

Electric Machinery

Geared pass-out turbo-alternators	Four
Rating	1500kW, 440V
Emergency	Two diesel-driven alternators
Rating	200kW

That the design of the ship is far removed from the traditional can be seen in our illustration of the liner on trial, the distinctive profile largely resulting from the decision to place the machinery aft. The funnels are balanced by a bridge structure and the ship has a curved and rounded stem associated with a ram/bulbous bow form below water, which is designed to reduce resistance and pitching. There is a cruiser stern of modern shape and the decks are arranged in echelon aft, while the lifeboats are stowed inboard under "A" deck. The lines of the underwater form were adopted after an extensive series of tests in the Denny tank and also at the National Physical Laboratory, while the design of the streamlined and well proportioned superstructure was subject to wind tunnel experiments. These established the pattern of airflow and the wind velocity distribution over the open deck spaces to determine the effectiveness of screens in providing adequate shelter for the passengers from the eddies and turbulence set up in the wake of the superstructure. Also governed by these experiments were the size, shape and height of the funnels and for this purpose the model conditions represented a ship speed of 27·5 knots, a wind speed of 20 knots ranging from dead ahead to dead astern and an efflux velocity of 90ft per second of gas at 375 deg. Fah. Although the latest addition to the fleet differs radically in size, speed and design from those ships built during the post-war period, the model in the William Fawcett Room, of the "William Fawcett", a paddle steamer of 206 tons, measuring 75ft by 15ft, powered by a 60 h.p. engine and built in 1829, is indicative of the history of the P. & O. by comparison with the ship of which it forms part of the decorations.

For construction of the main hull Quasi-Arc welding equipment has been used except for the framing, which is riveted. Welding has also been employed as a method of joining for the aluminium alloy superstructure which incorporates nearly 1000 tons of light alloy



(Left)—The crow's-nest at the forward end of the games deck. (Right)—Looking forward in the Meridian Room on the promenade deck showing the spiral staircase which rises to the crow's-nest

supplied by the British Aluminium Company, Ltd., and about 140 tons provided by Alcan Industries, Ltd. There are twelve decks, extending down from the sun deck to "J" deck, of which five, the promenade, "C," "D," "E," and "F" extend the full length of the ship. Within the hull there are partial lower decks, namely, "G," "H" and "J," while above the sun deck are the officers' deck, captain's deck, the navigating bridge and the wheelhouse top on which is mounted a streamlined signal mast. Subdivision is effected by fifteen watertight bulkheads, extending up to "E" deck, and these are fitted as necessary with Stones watertight doors and control equipment. There are twenty-one power-operated doors in the engine-room and "G" and "H" decks and, in addition, seventeen hand-operated doors on "F" deck. Oil fuel, water ballast and fresh-water are carried in the double bottom tanks; the fore and aft peaks carry fresh-water for which there is also provided a deep tank forward and one under No. 1 hold. Deep tanks for oil fuel are arranged aft of No. 3 hold, and in the pump-room and forward stabiliser compartment. Of the three cargo holds and 'tween decks, No. 1, which has special lock up compartments, carries general cargo, while No. 2 and 3 hold and 'tween decks are fitted in addition to take fifty to 100 motor-cars. To avoid loss of speed or use of increased power to maintain speed the ship is fitted with "Toxion" anti-fouling system for the destruction and prevention of marine growth on the underwater hull.

Passenger and Crew Accommodation

The fully air-conditioned passenger accommodation is arranged for 548 first-class and 1590 tourist passengers and there are, in addition, thirty interchangeable rooms which can accommodate either fifty first- or 100 tourist-class. Thus the numbers carried in each class may be 598 and 1590 or 548 and 1690 to provide for a maximum of 2238 passengers with the interchangeable cabins allocated to the tourist-class. Plastic materials have been used throughout the accommodation for passageway and divisional bulkheads and for the flush ceilings in the cabins.

Furthermore, extensive research into acoustics has resulted in the provision of special deckheads consisting of slotted plywood panels placed over a layer of soundproof material to achieve a considerable degree of silence throughout the ship.

The 305 first-class cabins, all of which have a private bath or shower, are located forward of midship on "A," "B," "C" and "D" decks with suites and de luxe cabins on "C" deck. The layout has been carefully planned and includes the introduction of "Court" cabins which embody the Bibby system in reverse in that instead of having individual access to the ship's side each inboard cabin has a window giving a view along the "Court" through the windows in the shell. With this system, the passageway widens towards the ship's side, where a settee and an occasional table is placed, so providing amenities for entertaining guests. Each cabin has individual control of the air conditioning, a telephone and a choice of two radio programmes.

Adequate space has been allocated for deck games on the sun deck and overlooking the swimming pool which measures 28ft by 23ft and is on the games deck and set within enclosing tiers of sunbathing terraces protected from the wind. Further forward on this deck is an enclosed games stadium and immediately forward is the crow's-nest which follows the radiused curve of the superstructure front in which are full height windows giving views over the port and starboard bows. For decoration there are two relief maps of Southampton water and Sydney Harbour, each having flashing lights to represent marker buoys indicating the navigable channel. Apart from entrances to port and starboard from the games deck, there is also a special staircase which rises through "A" and "B" decks from the Meridian Room on the promenade deck. Adjoining and forward of the first-class pool is the Bonito Club which has a centrally placed dance floor and raised decks at the sides forming a cafe. A hydraulically operated glass screen measuring 30ft by 10ft can be raised to enclose the Bonito Club or can be lowered so that the Club and pool area may be combined as a lido. The main lounge (Meridian Room), on the promenade

Looking forward in the first-class restaurant on "E" deck

General view from forward of the William Fawcett Room on the promenade deck

deck, also has associated with it a writing room and a library and, right forward, the Century Bar. This is enclosed by curving dark panelled walls which also form the entrance to the spiral staircase. An open plan has been adopted for the lounge and the decorative effect is obtained mainly from brightly coloured loose covers which fit over the foam plastic upholstered glass-reinforced plastic shells of chairs and settees. Further aft and to starboard is the Crystal Room which is intended to be used for parties and cards, and has walls of light grey wood veneer in parquet strips. The restaurant is on " E " deck, can seat 334 passengers, and extends the full width of the ship. To counteract the effect of such a large area in combination with a low height of ceiling there is a central sunken floor area matched by a raised ceiling, while pillar casings form screen walls and, together with high backed banquette seating arranged to form bays at each side of the ship, serve to break up the area visually. Varied lighting effects are used at meals, bright ceiling lighting during the day and subdued lighting in the evening. which will be used for dances and concerts. Part of the room will become a playground for children during the day by means of a sliding screen, while hinged screens at the sides of the room can be opened up in hot weather. A colourful plastic mural, depicting scenes in Ceylon and the Pacific islands, decorates the inner walls, while the furniture is mainly of laminated plywood. The children also have a play room to port and just forward of the Island Room. The remaining public rooms are in the promenade deck and right aft is the Peacock Room, with its adjoining card rooms, which is intended for reading and smoking. The walls are curved and are covered with dyed blue wood veneer and the furniture is made in bent pine plywood and covered in leather. Forward to port is the Cricketers' Tavern which is a long narrow room decorated with a montage of cricketing gear and has life sized portraits of eminent cricketers painted on outboard divisional screens. The corresponding room to starboard is the "Pop Inn" intended to satisfy the requirements of the teenage passenger and laid out on the lines of a coffee bar. The walls are of ordinary messes are arranged and there are promenade spaces on the promenade and " C " decks with the trunkway of No. 1 hatch being arranged for conversion to a swimming pool for the use of the crew. As for the passengers, the accommodation is air conditioned and the cabins have a built-in radio system.

Passenger and Ship Services

There are the usual amenities, including a shopping centre and hairdressing saloons, and the health of those on board is under the care of a medical staff. An extensive hospital block is located on " D " deck to starboard and includes waiting and consulting rooms, an operating theatre, four wards and two maternity wards. In addition there are crew and isolation hospitals on the port side of " C " deck aft. As already mentioned, the ship is fully air conditioned and the system, which has a total cooling capacity of 22,000,000 B.Th.U. per hour, has been designed, manufactured and installed by Thermotank, Ltd. The system is served by seventy central air-conditioning units which for maximum cooling purposes circulate 4400 gallons of chilled brine to fin-tube heat

Cricketers' Tavern on port side of the promenade deck

Tourist-class restaurant on " E " deck

For the children there is a well and imaginatively equipped play room on the games deck. About midships on " A " deck and with a dome extending through " B " deck is the cinema, which has a seating capacity of 332 and is equipped to show " Cinemascope " as well as standard films and has stereophonic sound equipment installed. The ceiling has been designed as a suspended acoustic shell. Our illustrations show the crow's-nest, Meridian Room and Restaurant.

For the tourist passengers there are 509 cabins, many with private showers, located aft of midships on " A," " B," " C," " D," " E," " F " and " G " decks. Recreational facilities are well provided for, there being a large area devoted for this purpose aft on the sun and games decks. On the latter deck is a lido consisting of a swimming pool, a paddling pool to port, and to starboard an area arranged with tables and beach umbrellas, the whole being enclosed by wind breaks covered with mosaic. Another pool is situated on " B " deck and has a fountain, which can be illuminated by coloured lights, arranged in the surrounding area. Adjacent to this pool is the room named Alice Springs, which by opening hinged aluminium glazed screens can be combined with the pool area. Around the walls is a multi-coloured glass mural embodying a free pattern of Fleur-de-Lys. On the games deck is the Island Room deal, into which free poker work designs have been burnt, and on which a number of students' paintings are hung. Continuing forward is the main tourist lounge, the William Fawcett Room, which is a large room having writing and reading rooms and a library at the aft end and outer walls of translucent silver-white glass fibre. The layout is on the lines of a palm court with fountains and the extensive use of mirror glass, including tinted mirror-glass murals, and the furniture is of bent plywood covered in bronzed green leather. Aft of the galley on " E " deck is the very large restaurant which can seat 704 people, the outboard tables being arranged in bays, which serve to conceal the apparent size of the room. The walls are of irridescent green-gold glase fibre and in each bay are abstract screen sculptures in metal. We reproduce photographs of the William Fawcett Room, the Cricketers' Tavern and restaurant.

The captain, staff captain, chief engineer and other senior officers have suites on the captain's deck, while other officers have single berth cabins on the officers' deck and in a house forward on the sun deck. Petty officers are on " C " deck forward, European stewards are on " D," " E " and " F " decks, and Goanese stewards are on " F " and " G " decks, while firemen and seamen have their cabins aft on " C " deck. Separate exchangers, while when heating is required a calorifier supplies warm brine to the air-conditioning units which are able to maintain an internal temperature of 70 deg. Fah. when the outside temperature is 20 deg. Fah. The fans move the equivalent of 50,000 tons of air per day and the total power absorbed by the Thermotank installation, which also serves the galleys, auxiliary and main machinery compartments, and cargo spaces, is 756 b.h.p. Spot coolers are provided in the laundry, bakery, pantries, &c., and workshops.

The refrigeration machinery consists of four two-stage centrifugal compressors operating on Refrigerant 11, each driven by a single-stage turbine of 547 b.h.p. These units deal with the demands of air conditioning and each is capable of abstracting 5·5 million B.Th.U. per hour. Output is controlled by speed regulation and when the duty falls to a low figure a standby compressor, forming part of the provision chamber machinery, will take over. For dealing with the provision chambers, which have an insulated capacity of 88,000 cubic feet, there are four eight-cylinder veebloc compressors, operating on Refrigerant 12, each powered by a 100 b.h.p. electric motor. Three compressors are adequate for holding duties, leaving one compressor available for air-conditioning purposes. In addition to

the refrigeration machinery, J. and E. Hall, Ltd., was also responsible for the manufacture and installation of the complement of lifts. These include: two first-class passenger lifts, one serving "G" deck to captain's deck and the other "F" deck to sun deck, and two tourist passenger lifts linking "F" deck with the games deck. There is also a lift for engineers which rises from the tank top to the captain's deck. For handling stores there are a total of six lifts which cover the range from the tank top to the games deck, while for pantry service there are two lifts, one rising from "H" to "E" deck and the other serving from "E" to sun deck. Right aft there is a lift serving "F" and "E" decks in the laundry.

For dealing with the ship and passengers' laundry requirements there has been installed at the aft end of "E" deck a fully equipped laundry, part of which can be seen in our illustration, mainly fitted out by Isaac Braithwaite and Son, Engineers, Ltd. Included are washing machines, hydro-extractors, side loading washing machines, drying tumblers, a Manlove Alliott three roll calender and a battery of presses. Since hundreds of tons of water are used each day in the laundry, in the interest of economy most of the rinse water is processed and recovered ready to be used again. For passengers' personal use there are, in addition to the main laundry, a number of launderettes which are equipped with domestic size washing and spin drying machines.

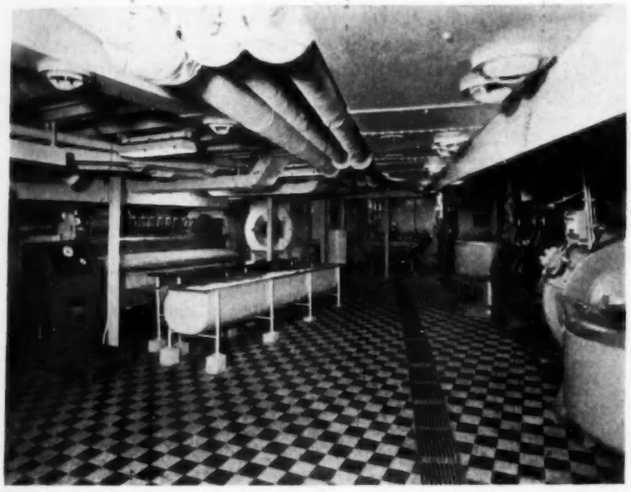
To reduce the amplitude of roll induced by rough seas there are two sets of Denny-Brown stabilisers which can be operated together or independently and guarantee a maximum righting moment of 18,000 tons feet. The fins, of aerofoil shape, have an area of 90 square feet each, a chord of 7ft 3in and extend horizontally 12ft 6in from the ship's side at a point 22ft below the waterline. They oscillate through a maximum of 20 deg. above or below the mid position, the torque available being 150 tons feet, and the time required for this movement in "Canberra" is about 2·9 seconds. A V.S.G. variable delivery servo controlled pump, driven by a 35 h.p. electric motor, provides the pressure for operating the oscillating rams. Overall control equipment of "compensated control" design has been provided by Muirhead and Co., Ltd., and consists of two gyroscopes which, in conjunction with a mechanical differentiator and fin angle transmitter, produce five control functions, namely, roll angle, velocity, and acceleration, fin feed back and natural list. These are combined automatically to give the best results. Control panels are sited in the stabiliser compartments and on the bridge.

Out of a total population on board of about 3200 some 700 form the catering staff, and the ship's main galley, situated on "E" deck between the restaurants, is a compartment which occupies the full width of the ship and has a length of 150ft. Stainless steel has been used throughout and the equipment includes ovens and other items supplied by the Carron Company, and Hobart dish washers, &c. On the deck below is a fully equipped bakery, the butcher's shops and fish preparation room. One of the particular innovations introduced into the ship are the cargo transporters, which have been designed and built by Carron Company to operate through the ship's side at "D" deck level. The two units, which can operate on either side of the ship, serve No. 2 and No. 3 hatches, and when extended project 33ft outboard. There is a light alloy platform for handling cars direct from the quayside, the total load being 3 tons, while another platform having a wooden deck is available for cargo handling. For baggage handling the company has provided transporters of boom pattern and these are mounted in the first-class baggage loading spaces to port and starboard on "D" deck. The cargo transporters were described in THE ENGINEER of January 15, 1960. Mechanised baggage and stores handling gear has also been supplied by J. Collis and Sons, Ltd. For the tourist baggage there is a cross deck conveyor that can be extended through the ship's side to port or starboard and consists of three interconnected slat conveyors carried by a traversing gantry. The outboard conveyor can operate at any angle between 15 deg. elevation and 30 deg. depression and provision has been made to allow for any ranging of the ship in a fore and aft direction. The conveyors run at 60ft per minute and have a load capacity of 50 lb per foot run. Cabin baggage is loaded into an elevator, which serves "A," "B," "C," "D," and "E" decks and consists of trays carried by endless chains running over sprocket wheels at top and bottom of their travel. The trays travel upwards loaded and discharge as they descend and the whole operation of discharging at a selected deck is automatic. Generally, similar arrangements are installed for serving the baggage room except that there are two swan-necked conveyors permanently installed between the side doors on "E" deck and the baggage room on "F" deck. The stores conveyors, of which there are four, are of simpler design and operate at "E" deck level. Each is carried on a gantry which runs outboard and lowers the conveyor into position.

Apart from supplying the extremely varied lighting system and allied fittings, The General Electric Company, Ltd., has installed a 500-line, two-position manual switchboard, to provide a telephone service for the passengers, and a 200-line automatic telephone exchange for use by the crew. First-class passengers will be able to take telephone calls in their cabins through the ship's exchange wherever the ship may be, and when the ship is within 300 miles of the United Kingdom radiotelephone calls can be obtained with the same ease as for trunk calls. The Marconi International Marine Communications Company, Ltd., has provided the communications equipment and navigational aids, including a single sideband transmitter, a "Globespan" transmitter and three "Atlanta" receivers, a "Lodestar" automatic direction finder, together with a "Metron" which indicates the actual depth of water below the ship. Marconi's Wireless Telegraph Company, Ltd., was responsible for the television installation, which provides a co-ordinated internal and off-air service. Provision is made for reception of the 405-line system of Britain, the 625-line system of Australia and Europe and the 525-line system used in the Americas. There are special closed circuit television programmes which also make provision for commercial advertising.

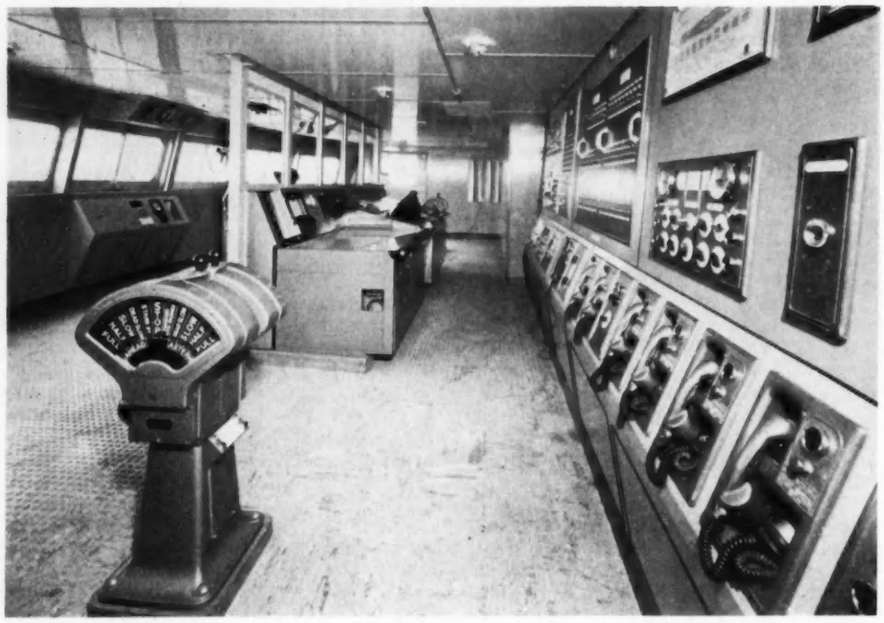
Basically, the radar installation, supplied by Kelvin and Hughes (Marine), Ltd., consists of two true motion systems, each complete with its own basic controls. The master displays are incorporated in a navigational console combined with a chart table. One display is a 16in P.P.I. unit and the other is a 24in diameter "Bright Display" of radar information in either relative or true motion presentation. This is produced by projecting on to the display surface a sequence of rapidly processed photographs of a special cathode-ray tube, and the time cycle between pictures can be varied from three-and-a-half seconds to sixty seconds. Two 10ft slotted waveguide scanners form the aerial system.

Steering is effected by electro-hydraulic gear, manufactured by Brown Brothers and Co., Ltd., which is of four-cylinder Rapson slide design having two power units



View of port side of laundry on "E" deck, aft

View looking aft of the galley on "E" deck



Port to starboard view of wheelhouse showing the navigation console and the main control console

each consisting of a 275 b.h.p. motor driving a size 50 V.S.G. variable delivery pump. Each power unit is capable of full duty and the gear is arranged so that five combinations of the hydraulic cylinders can be used. With four cylinders and one power unit in operation the maximum working torque exerted is 2050 tons feet and the equipment can move the double-plated streamlined rudder, which weighs 42 tons, from 35 deg. port to 35 deg. starboard in thirty seconds. With the second power unit in operation the time from hardover to hardover is reduced to eighteen seconds. There is an auto-electric steering control system developed by S. G. Brown, Ltd., and this includes an Arma/Brown master transmitting gyro compass. Rudder application is initiated by two after power units directly coupled to the control valve of the steering gear. To assist the ship in close navigation and docking an electrically driven "Pilgrim" bow propeller has been mounted in a transverse tunnel, 6ft 7in in diameter and located about 80ft from the forward perpendicular and 20ft below the water line. The propeller has two blades, to permit easy removal into the ship, a diameter of 6ft 6½in by 5ft 9in mean pitch and was manufactured by Manganese Bronze and Brass Company, Ltd., in Nikalium. Power is provided by a Harland and Wolff 800 b.h.p., 3300V, 60 c/s motor having a synchronous speed of 1200 r.p.m. and a full load speed of 1183 r.p.m. Allen West starting equipment operates the motor at four speeds, namely, 800, 935, 1105 and 1183 r.p.m., the corresponding horsepowers being 247, 395, 650 and 800. The drive is through a Hindmarch/Modern Wheel Drive reversing gearbox, having a gear ratio of 1 to 1, via an input shaft in the propeller pod and a bevel gear having a ratio of 51 to 13 to give the speeds of 200, 233, 266 and 300 r.p.m. At these speeds the propeller has a corresponding thrust of 3·8 tons, 5·1 tons, 6·7 tons and 8·5 tons, respectively, and is effective when the ship has a speed of 6 knots or less.

Viking Marine, Ltd., using material supplied by Fibreglass, Ltd., has built the complement of lifeboats, which consists of six 36ft motor boats and sixteen 36ft hand-propelled boats, together with two specially designed accident boats. All are stowed inboard under "A" deck and carried under nickel-aluminium bronze davits produced by Welin-Maclachlan Davits, Ltd. Each boat is suspended from a pair of davit beams running on wheels in sloping trackways slung from the underside of "A" deck. For "man overboard" emergency there is an Elliot four-man inflatable life raft mounted at the stern and held by a Schermuly quick release gear.

Deck machinery supplied by Clarke Chapman and Co., Ltd., includes a four-headed anchor cable and warping capstan set to handle the bower anchors and the 3$\frac{9}{16}$in steel cable and to give a 24 tons pull for warping duties. Power is provided by two 140 h.p. motors and 116kW 175 h.p. motor generator sets mounted on the deck below. The cable lifters can handle 105 tons at 21ft per minute with both motors or 56 tons at the same speed or 112 tons at 10½ft per minute with one motor. A warning device consisting of a geiger scanning unit, mounted in the hawsepipe, which is activated by a small radio-isotope housed within a joining shackle, rings a warning bell so that anchor housing speed is reduced and over-winding prevented. There is an aft centre line capstan-windlass which has the following duties: 16½ tons at 38ft per minute from the cable lifter handling 2$\frac{1}{16}$in steel cable and 22½ tons at 36ft per minute from the warping head. Three warping capstans are fitted, two aft and one forward, and each, as well as the capstan windlass, is driven from an 80 h.p. watertight motor mounted below deck with a 68kW 100 h.p. motor generator set. Cargo at No. 1 hatch is handled by two Ward-Leonard controlled winches, each able to lift 3 tons at 100ft per minute. In addition there are four 5-ton and three 2-ton conveyor hoists for baggage handling. The ship is also equipped with two Pitt-Scott tensioning winches which will automatically maintain a selected tension in a cable. Each winch is powered by a 50 h.p. d.c. motor, operating on a variable voltage system, and supplied by its own motor generator. The winches have a range of 2500 lb to 15,000 lb pull in automatic and up to 20,000 lb pull in manual control.

For fire protection the Grinnell sprinkler system has been installed, while "Castador" fireproof doors shut off one zone from another and the Walter Kidde Company, Ltd., has supplied a smoke detection system. Controls and indicator panels for the various services and communication systems are grouped in a console provided by Clifford and Snell, Ltd., which together with navigational equipment is mounted in the wheelhouse of which we reproduce a view.

(To be continued)

Some Aspects of Engineering Education

By SIR WILLIS JACKSON*

Below we reprint an extract from the 1961 *Viscount Nuffield paper presented last Wednesday, June* 14, *before the Institution of Production Engineers. Sir Willis can seldom speak in public without reference to the subject of education. The extract we have chosen deals with that subject with, of course, special reference to the education of production engineers. Too early and too much specialisation is criticised and how to interest graduates in production is discussed.*

IT is, I think, self-evident that the pursuit of scientific discovery and of its technological exploitation cannot be restrained—not by unilateral decision of individual countries at any rate—and that if we, in particular, are to maintain our standard of living and our influence in the world at large, we must remain in the forefront of scientific and technological endeavour and achievement. This accounts for the great emphasis which has been laid during recent years on the need for a larger number of our most able young people to be attracted to the prolonged study of science and its applications. Estimates have been made of the increased annual output of scientists and professional engineers during the next decade, and our universities and colleges of technology are being expanded to cater for it. I do not propose to comment on these estimates. I am more concerned here with the nature of the education these young people should receive in preparation for the rapidly changing situation which lies ahead of them; and in this respect I shall refer only to engineers, with the needs of production engineering particularly in mind.

* Director of Research and Education, A.E.I. (Manchester), Ltd.

Education Must be Broad

The first aspect of this changing situation which I wish to mention is the growing interdependence of the various branches of engineering. Inevitably in the early stages of his career the young engineer must become something of a specialist. Equally inevitably, however, he will become a first-class specialist only if he is knowledgable about, and capable of appreciating the significance of, what is happening in other specialities which may come to impinge upon his own.

This requires that his educational preparation must be as broad as possible. I myself incline towards a common course for all engineering undergraduates during their first and second years, with subdivisions into civil, mechanical, electrical, chemical and aeronautical engineering deferred to the third year, and with specialisation within these main branches still further deferred until the post-graduate stage. The danger of too early specialisation is that the young engineer seeks to find the solution to his technical problems in terms of his speciality. For example, an electrical engineering graduate who has been permitted to concentrate on electronics in his final year will almost inevitably seek an electronic solution to a problem in automatic control notwithstanding that it may be better engineering to use an hydraulic or pneumatic one. Breadth of undergraduate preparation seems to me to be particularly important for those who will later choose the production side of engineering work. I hope most sincerely that you will not press for the introduction of an undergraduate sub-division devoted specifically to this side, though I by no means mean by this that its importance and potentialities should not be drawn to the attention of students during this period.

Indeed, there is good reason why it should be. Not, however, in a technical sense so much as in illustration of the vital importance of human relations in the practice of engineering. Little of a formal character can perhaps be done at this stage, but what must be achieved is to open the mind of the student to the fact that exclusive devotion to a scientific and technical discipline will not give him all he needs in preparation for a career in engineering, and for life. Modern engineering is a major exercise in team work. Considerable scientific and technical knowledge are necessary for success, but by themselves give no assurance of it. An interest in, and the ability to resolve, human problems become of increasing importance, to all engineers ; for those who choose to make their career on the production side, they are vital.

Liberal Studies

Many experiments in so-called liberal studies are being made in the universities, and they should be encouraged because they afford a valuable opportunity for breaking down interdepartmental and interfaculty barriers. These experiments will be really successful, however, only if the teachers of engineering themselves provide a bridge by constantly referring to the humanistic aspects of engineering in the teaching of their respective subjects. And it cannot be over-emphasised that the most liberalising influence of all is probably that of active participation by the undergraduate in the corporate life of the student body. It is gratifying that the opportunities for this within the provincial universities are being enhanced considerably by the rapid growth of residential, and the considerable improvement of student union, facilities.

Movements in undergraduate courses in these directions will necessarily leave for acquisition at the post-graduate stage an increasing amount of more specialist knowledge. As seen by some the best solution would be to increase the duration of undergraduate courses from three to four years. Fortunately from my point of view, this step will be physically impossible during the next decade, since such expansion of our universities as will be achievable is likely to be fully absorbed in catering for the mounting number of young people, qualified for university entry, now emerging from the schools. For engineers, three years at a university is surely long enough preliminary to participation over a substantial period in the practice of engineering. This participation I regard as a prerequisite for the wise selection of a particular speciality within one of the main branches of engineering, and even more so for the selection of production engineering as a subsequent career.

Graduate Apprenticeship

The opportunity to gain a broad, basic, appreciation of the practice and organisation of engineering work is provided by well-planned schemes of graduate apprenticeship. This training is usually of two years' duration immediately following graduation and in my own company the second year is planned in close collaboration with, and is conducted under the sponsorship of, senior representatives of the functional activity which has been jointly selected—research, development, design, manufacture, &c. Contrary, it would seem, to the experience of some other companies, the manufacturing functions proves with us to be an attractive one to many of the best of our graduate recruits. Once well started, this is of course a self-propagating process, but it requires for its sustenance not only satisfying training and employment subsequent to selection, but also adequate preparation of the mind of the first year graduate apprentice for a kind of engineering work which follows less naturally than do research, development and design from his university preparation.

Training for Production

This may seem to argue for more specific attention to such subjects as workshop technology and industrial organisation at the undergraduate stage. I see it more as a responsibility of, and a challenge to, the production side of the company to present their side as making intellectual demands which are no less severe, and as requiring men of no less intellectual calibre, than those of research, development and design—and as affording greater scope in the field of human relations. If an adequate number of good graduates are to be attracted to the production side, its senior representatives must be at pains to see that it is presented during the first year of graduate training as a progressive, stimulating and searching sphere of engineering activity, which demands the best and is determined to have them : and, having got them, they must be given ample opportunities not only to gain a varied experience, and a satisfying measure of responsibility as soon as possible, but also to broaden and strengthen their knowledge by participation in appropriate post-graduate courses.

Responsibility and Authority

In stressing the latter, I must make clear my appreciation of the limitations which attach to such of these courses as deal with management studies. The ability to acquire knowledge is one thing—the ability to carry responsibility and to exercise authority in relation to this knowledge is quite another. The only effective means of establishing that a man can carry responsibility is, of course, to put him in a position where he is obliged to do so. In no other way can he demonstrate the possession of certain essential personal qualities and abilities. When this has been demonstrated by success in one situation, it is a characteristic of good management that he will be tested and matured in others of greater complexity, with the advice and example of his more senior colleagues to guide him.

Nevertheless, a great deal of thought has been given during recent years to the question of what can be done outside the immediate environment of employment to assist this process. Is there a framework of general principles and a systematic body of knowledge about industrial organisation and management which, properly presented, will guide and assist young engineers the better to assess their personal experiences in this field ? Can anything be done—in courses—to develop a man's ability to recognise and appreciate the significance to his own field of work of the activities of others engaged in related fields ; to organise co-operative effort among men of whose respective specialities he may have only limited detailed knowledge ; to draw reliable deductions from, and make sound decisions on, inadequate evidence and in insufficient time ; and to represent the views of other people, as well as to express his own, clearly and concisely ?

Much has been written on these and other related questions, and many post-graduate experiments are being tried within the universities and technical colleges, and through the medium of staff courses organised by industrial concerns and public authorities. The anxiety attaching to the former, particularly where the students lack outside experience, is lest they may assume that successful participation in a course of study will automatically endow them with the qualities essential to good managers. It is of the greatest importance that this danger should be avoided.

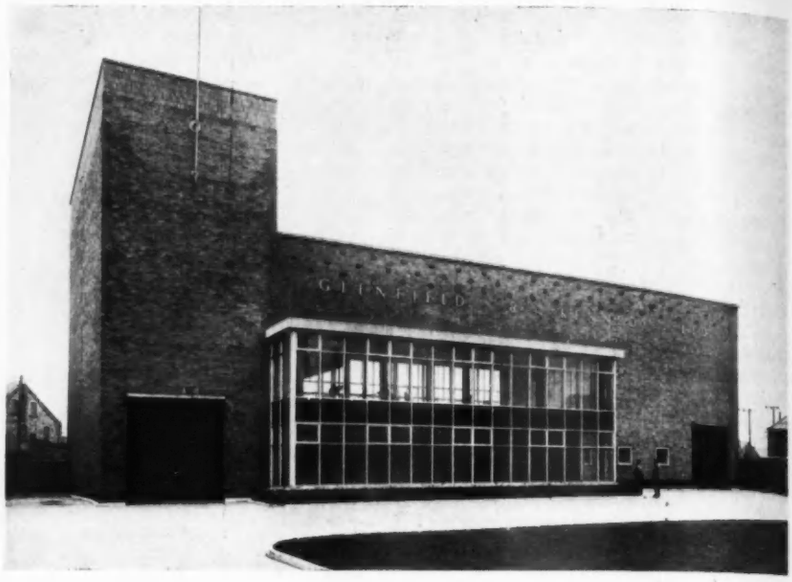
"Thick Sandwich" and Dip. Tech.

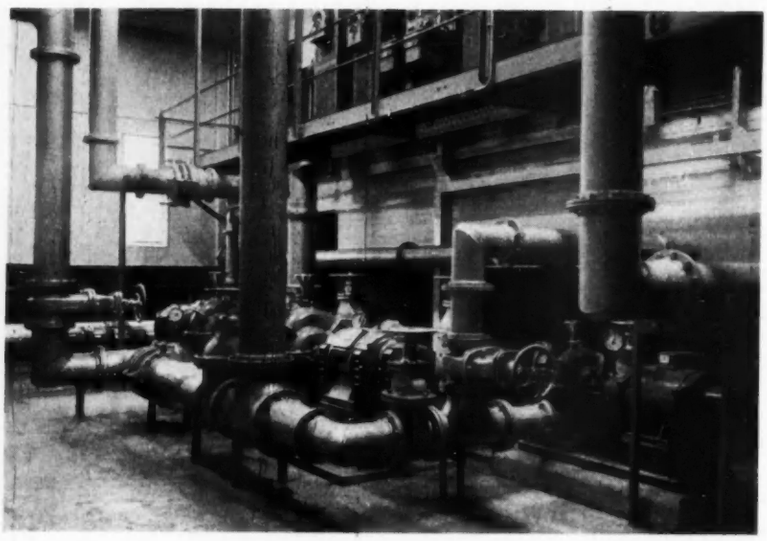
Before leaving the professional grade of industrial personnel I must mention my strong attachment to the arrangement by which intending university students of engineering spend a year in industry between leaving school and entering the university. I wish this 1 : 3 : 1, or thick-sandwich, arrangement could be made more general. It brings to the university men of more mature outlook, much better able to appreciate the purpose of their engineering studies and the need for the pursuit of broadening interests ; and it enables those who may not be suited to engineering work to transfer to another subject of university study without serious loss of time and with some gain in experience of life. The prerequisites are, however, that the scheme of training must be well organised and purposeful, and that it must provide for the continuance of scientific and mathematical study on a part-time basis of one day per week.

A further variant is provided by the five-year courses leading to the Diploma in Technology which were introduced into our larger technical colleges some six years ago. Much, if not all, I have said about university courses applies to them with equal force, but what may prove to be of particular value to the production side of industry is the prospect of a much closer co-ordination of college study and industrial training. Although I hesitate yet to accept it, a case can undoubtedly be made for distinctive Dip. Tech. courses in Production Engineering. At least it is clear that here, more than in degree courses, is the opportunity to explore a more scientific approach to the subject of workshop technology ; and great scope for experiment in presentation of the humanistic aspects of engineering work as an integral part of the scientific and technical studies. And what is even clearer is that the Colleges of Advanced Technology are in a particularly favourable position to conduct, in partnership with industry, advanced courses of a few weeks' or months' duration on specialist subjects relevant to the needs of their respective regions.

Hydraulics Laboratory at Kilmarnock

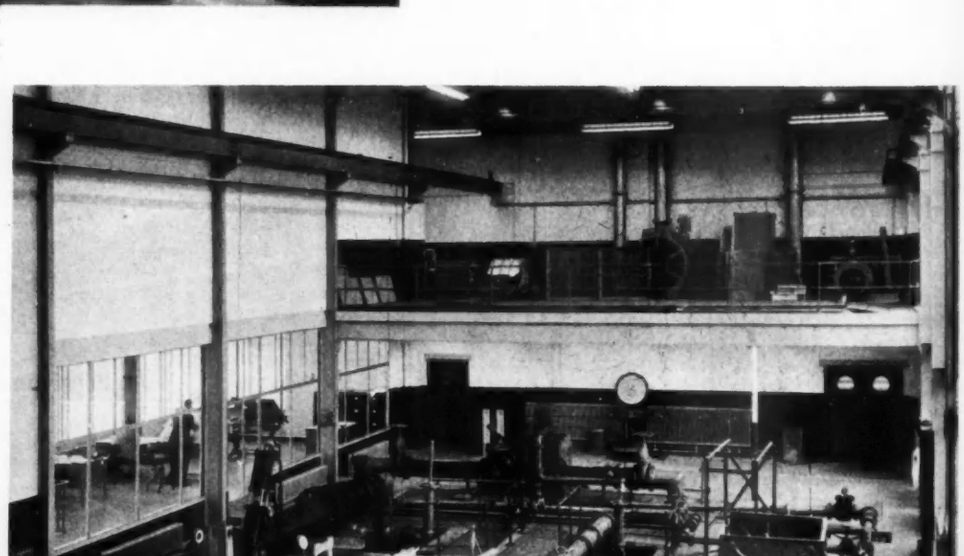
The hydraulics laboratory RIGHT was inaugurated last week ; it has been built by Glenfield and Kennedy, Ltd., at that firm's Kilmarnock works, and is to be used by all the companies in the Glenfield group. The laboratory itself (BELOW RIGHT) is on the first floor and is built over a storage tank of 22,000 gallons capacity. The pump room, (BELOW LEFT) is on the ground floor of the tower of the building, with, above it, the model gallery shown in the background of the bottom illustration, and above again, a constant-head tank of 14,000 gallons capacity. There is also a drawing office, pipe storage gallery, machine shop, and office space, and an aerodynamic laboratory of 400 square feet is to be equipped on the top floor, since certain tests can be carried out very conveniently using air instead of water.





There is an increasing demand—partly from the group's customers for valves, sluice gates, &c.—for objective test data, either to develop or substantiate claims for a new product, or assess the performance of those regarded as well-tried and established. In addition, design detailing of spillway crests, gate openings, &c., can be readily evaluated. The laboratory will also be used to build up a fund of information on the performance of various valves, and other devices. In one test, for instance, on disc stop valves in the range of diameters 8in to 24in, comprehensive tests aimed at investigating the behaviour of the valve seating, operating and pull-out torques, head loss, head recovery downstream of the valve, evaluation of actuation by a pneumatic cylinder, and operation as a free discharge valve, are in progress. The rig for one of these tests can be seen in the lower view, the cylinder being clearly visible.

There are four pumps installed (2 of 10 cusecs at 35ft head, one of 1 cusec at 450ft head, and one of 2½ cusecs at 42ft head) giving flows up to 20 cusecs at 35ft head, and smaller flows at up to 450ft head. The maximum variation on the constant head tank (giving 36ft head above floor level) is $\frac{3}{8}$in. A weighbridge of 2 tons capacity is used (with a spear control valve) to measure flows up to 2 cusecs with great accuracy. And there are three venturi meters calibrated to within ½ per cent—one 6ft (0·4–1·8 cusecs), one 12in (1·3–6·0 cusecs), and one 18in (4–20 cusecs). A great deal of thought has been given to the installation of pipes and valves to ensure convenience and flexibility in setting up test circuits, and obtaining good velocity profiles. The services are comprehensive, including compressed air, a 5-ton lift, and filtration and chemical treatment of the water in circulation.



Future of Electricity in Britain

The presidential address to the British Electrical Power Convention, held in Eastbourne this week, was given on Monday by Sir John Pickles, chairman of the South of Scotland Electricity Board. Sir John's address ranged over the present and future of electricity supply in Great Britain. We give extracts from that part of his survey which examined the industry's prospects for 1960–80 *and, more tentatively, for the last two decades of this century.*

THE pattern I have chosen for my address compels me to head my last section 1960–2000, although no one would be imprudent enough to be dogmatic about the later stages of such a long period. Nevertheless, without being fanciful, some conjecture must be made. It is, after all, no more than the length of the normal professional career. I confess to some surprise on reflecting that young men entering the industry this year may still be signing correspondence in the year 2000. Perhaps if we look forward in stages we shall get a fairly firm picture of the first ten years, a not unreasonable one of the second decade, and some speculation up to the year 2000 when this year's entrant will be turning his thought to his superannuation prospects.

We see this in the domestic field, where, well within our own recollection, the first introduction of electricity to our homes was in substitution of older methods of lighting and heating. Now we are in a period where the all-electric home, in the full sense of the term, is with us. Present housing programmes include a significant and growing proportion of dwellings in which no other fuel will be used. The domestic chimney is being rapidly outmoded. The same trend applies in shops, offices, schools and other public buildings, where off-peak tariffs are playing such an important part. Willing consideration is now given by public authorities, private builders and architects, to proposals which only a few years ago would, on the grounds of tradition alone, have been given scant attention. All Boards can testify to the avalanche of load reaching them from domestic and commercial premises.

To take only one aspect of the immediate future, no other recent measure has a greater potential effect on electricity developments than the Clean Air Act of 1956. Apart from its immediate impact on the design of all new buildings, the Act should result, in the next ten to fifteen years, in at least 6,000,000 existing dwelling houses and over 1,000,000 commercial premises being changed from the burning of raw coal to the smokeless fuels, such as prepared coal, coke, oil, gas and electricity. It is doubtful whether the industry has fully realised the potential electrical load involved. From the experience already available from the early smokeless zones, it seems likely that electricity will be chosen as the sole fuel by the occupiers of at least half of the houses. The additional after diversity demand will be at least 1kW per house. On this reasoning, the possible increased demand from this one source alone is of the order of 3000MW, subject to what can be kept off-peak when suitable domestic storage heaters are available.

Expansion of use in general industry continues unabated in process work, in motive power and in automation and control. Furnace loads and other heat processes are rapidly being transferred to electricity, particularly in the steel, ceramic, and glass-making industries. The winning of coal, the manufacture of gas, and the refining of oil make substantial and increasing demands. Railway electrification is in full swing. In heavy industry, individual new loads of 50MW to 100MW and over are not uncommon.

Without going over other fields in detail, I have, perhaps, said enough to show that the picture is one of all round expansion of the use of electrical energy. Every new use seems to pave the way to yet another use. In the last calendar year the units sold in the United Kingdom increased by 13 per cent over the previous year. Our costs place us in a most favourable position to compete with all other fuels. Electricity is, in fact, at the very root of the objects for which we are all striving—the elimination of drudgery, the saving of manpower, better health and an improved standard of living. In short, everything points to the conclusion that the industry seems poised for a further period of continued expansion on a very substantial scale.

1960 to 1970

Against this background, let us consider the ten years up to 1970. The practice is to prepare estimates for seven years ahead, the first five of which are firm and form the basis of the generating plant programme, the sixth is regarded as provisional, and the seventh as tentative. Each year, with a further year's experience available, the estimates are revised and pushed one year further ahead. They are the result of a many cornered exercise in which the Area Boards, the Scottish Boards, the Generating Board, and the Electricity Council, first estimate independently and finally in concert. They are a combination of experience, observation and judgment. On the basis of such estimates, with a slight extrapolation for the last few years, there seems no reason to doubt a doubling of consumption by 1970.

But can the consumption go on doubling every ten years? Are we in danger of regarding this as an immutable law? To continue at this rate for the next forty years would mean, even allowing for greatly improved load factor, that our present installed plant of some 30,000MW would rise to over 400,000MW ; a prospect which our manufacturers would no doubt relish, but a formidable thought by any standard.

In passing, it may be noted that in exercises of this kind, one finds oneself returning again and again to the generating plant position, for the reason that this is the focal point at which all expansion comes out as a single figure of plant required. The hub of all our problems is the manufacture and progressive commissioning of sufficient plant to meet the prospective peak demand. This is in no way to overlook the corresponding programmes for extensions of the transmission and distribution systems, but which cannot be expressed in a single figure like that of the generating plant.

1970 to 1980

Let us now look forward, albeit with appropriate caution, a further ten years to 1980. Once more the first questions are, can the pace continue? When will the deceleration commence? At this point, it may help to note what other countries are thinking, for they also have these problems in forecasting future needs. In this connection, the Economic Commission for Europe recently published some useful forecasts gathered from various countries and covering the period 1960–75. All anticipate considerable expansion, in some cases at a rate lower than Great Britain and in others at a higher rate. The following derived figures of four countries will assist our consideration. They comprise the estimated gross requirements of electrical energy in the countries concerned, expressed in each case as increases from an index figure of 100 in 1960.

	1960	1965	1970	1975
France	100	144	200	286
West Germany	100	135	186	255
United Kingdom	100	135	180	230
United States	100	131	165	203

The report observes that, in general, long term estimates of electricity demand tend to be conservative. This is especially so of estimates sponsored by Government sources, perhaps because of the doubtful eye with which those who control the purse strings regard projects involving high capital investment ; perhaps, also, because privately owned organisations visualise a more vigorous expansion than Government circles deem prudent.

Nevertheless, it will be seen that in France a doubling in each period of ten years is anticipated. In West Germany the position is similar. The United Kingdom estimates show a growth of somewhat less than this, but it may well be that for the reasons mentioned above, these estimates are conservative.

For the U.S.A., the figures show a doubling in fifteen years, but the report notes specially that these are Federal Power Commission estimates and that alternative estimates recently submitted by various representative organisations to a United States Senate Committee are very much higher. A mean figure shows a doubling in ten years rather than fifteen years. Incidentally, in terms of plant installation, such a rate of growth involves some very impressive figures. As against an installation of 12,000MW of plant in the U.S.A. during 1960, one estimate I have seen anticipates the installation of 27,000MW during the year 1970, and no less than 45,000MW in 1980. This trend is of special significance, because it starts from a base where the present consumption is already 4500 units per head of population, despite the competition of cheap coal, natural gas and oil. Speculative estimates of consumption per head of population in the U.S.A. in the year 2000 show a very wide bracket, but the mean figure is about 20,000 units per head per annum.

The report does not cover Canada, but present consumption there is higher than in the U.S.A. and exceeds 6000 units per head of population. Nevertheless, it is estimated that the present annual output of about 100,000 million units will quadruple and be around 400,000 million units by 1980 when, allowing for population increase, the consumption per head may be in the region of 16,000 units a year.

The present United Kingdom figure of annual consumption per head is slightly over 2000 units, or less than one-half of the present U.S.A. figure and one-third that of

Canada. Making all allowances for the different circumstances—climatic, social and economic—these U.S.A. and Canadian figures, established and projected, nevertheless give a pointer to the very large potential increases that we may experience, even though our ultimate ceiling may be lower than theirs.

Returning now to our own prospects in the period 1970–80, one cannot conceive that the factors at present compelling expansion will by then be spent. There may emerge some restraining factors, social or economic, or even international. But I can feel no doubt that the potential expansion will still exist. Moreover, note must be taken of our increasing population which, it is estimated, will have grown by 10 per cent by 1980. Trying hard to keep one's feet on the ground, it does not seem at all impracticable for the 1970 consumption to be doubled again, possibly by 1980, or by 1985 at the latest.

Let us now consider briefly what expansion on this scale during the twenty years from now to 1980 implies in the various sections of our industry.

In generation, it implies that our present installed plant of some 32,000MW will have increased to a figure approaching 60,000MW by 1970, and to more than 100,000MW by 1980–85. Manufacturers can derive the annual plant requirements not overlooking that, apart from new plant to meet growth in demand, the replacement programme will by then be very substantial and will increase year by year. It should not be a displeasing prospect for them. We shall have passed the coal availability ceiling and, towards the end of the period, it seems likely that the greater part of the new generating plant will be nuclear but, due to its low capital cost, conventional thermal plant may still be justified in many cases, especially for replacements in existing buildings. The 1000MW set may have made its début—an 800MW set has already been ordered in the U.S.A. The operation of large generating sets and boilers will be controlled by computers. In transmission, still higher voltages will have been adopted—a 750kV system seems not unlikely.

Distribution will have necessitated greatly extended high-voltage systems with transformers for every twenty houses or so. Transformers must be much improved in compactness and reduced noise levels. Switchgear must be simplified and cheapened. Doubtless the insulation of low-voltage underground cables, if not of high-voltage cables, will be of the extruded plastic type, possibly without metallic sheathing. Modern buildings are of such size that installed loads are expressed in megawatts. Many already require high-voltage vertical distribution cables and this type of installation will become commonplace. The installation contractor can view the future with great confidence. There must be a development around the corner which will bring supervisory control of consumers' installations back into its own. What a boon this would be in the control of off-peak load. Time switches would be virtually eliminated and generating plant could be loaded in a near ideal manner. With the increasing dependence of the consumer on electricity, continuity of supplies will have become even more vital. Contributions to this will be made by more live line working on high-voltage lines, and by greatly extended adoption of automatic reclosing on high-voltage networks—a practice which is in itself capable of creating almost revolutionary improvements in continuity.

On the commercial and utilisation side, whilst electricity, or for that matter any other commodity or service, will never sell itself, it will become much easier to sell and commercial staff will be more concerned with service than with selling. It is to be hoped that progress will be made in two aspects of consumer service which at present are unsatisfactory, namely, the existence of many old and unsuitable wiring installations, and the continued marketing of cheap and shoddy appliances. The activities of the National Inspection Council and the newly established Approvals Board will cover most new installations and appliances, but new powers may be required to deal with old installations and with appliances which have not been approved.

On the administrative and financial side, developments will have kept pace with changing conditions. There will be greatly increased mechanisation in secretarial and accountancy practice. The quarterly meter reading and account will have been replaced, perhaps, by a fixed monthly charge adjusted to meter readings made once or at the most, twice a year. The industry will gradually approach and may well attain a position of complete self-financing in which new capital expenditure is met from earnings. Surely time will have been found to amend and consolidate the legislative provisions which have piled up on us in a series of Acts from 1882 onwards. The way in which succeeding Acts have revised earlier ones is such that it is now impossible for lawyer and layman alike to make quick and confident reference to them. It is to be hoped that we shall also see the introduction of a decimal coinage system and, if not the metric system, a simpler method of expressing weights and measures.

1980 TO 2000

Now a further and final look ahead. What can be said by way of conjecture about development in the period 1980–2000? Here it is easier to pose questions than to make predictions, for so much depends on the results of research and the ultimate practicability of many things which at present are little more than visionary.

Once again, using generating plant as our index, if, as previously suggested, 100,000MW is installed by 1985 at the latest, and if annual increase thereafter is not more than 3 per cent, the plant installed will exceed 150,000MW by the end of the century. If the increase proves to be 5 per cent, then 200,000MW of plant would be required. These figures should not be taken as more than illustrative of the possibilities.

A vital question is what fuels will then be available. A prospective shortage of coal, forecast for the middles 'sixties, but now likely to be somewhat later, has already forced the industry into a three fuel economy based on coal, oil and nuclear energy. Estimates of world resources of fossil fuels vary in a most bewildering manner. I have read so many seemingly authoritative statements on the reserves of coal and oil that I have come to the conclusion that nobody knows with any certainty. Some appraisals of the oil situation place a surprisingly short life on known reserves, but one is left with the feeling that as more or deeper drills are made, the known reserves will increase. For example, the natural gas resources of Western Canada, now playing such a great part in that country's economy, remained unsuspected until comparatively recent years. With coal, apart from the reserves actually available, there is the further uncertainty as to how long men will be willing to continue the disagreeable process of its extraction. Uranium reserves, on the other hand, seem sufficient to give no cause for anxiety for a very long period ahead.

Estimates and statistics apart, one can generalise by noting that fossil fuels are a wasting asset with a finite life and that their cost will increase as they become scarcer. No one can doubt the prudence of our searching for substitute sources of energy, such as wind, tides, or hydro energy, limited though their contribution may be, and nuclear energy, expensive though the earlier stations may be. Although cold comfort to those bearing the anxieties of our present nuclear programme, it is certain that those in charge of the industry in the 'eighties and experiencing the real pinch of shortage of coal and oil will applaud the pioneering now being done.

Will this be the era of fusion rather than fission? No one can be sure, but one aspect is worth a thought. If fission, as we all hope, has provided a cheap and reliable form of generation, it is possible that the enormous cost of research and development of fusion will not be justified for what may be only marginal gains.

Will there be direct conversion from heat to electricity without the intervention of a steam cycle? In this field, attention is focussed on thermionic, thermo-electric and magnetohydrodynamic (M.H.D.) generation. The first two seem highly speculative both in time and practicability and, together with the fuel cell, may for our present purpose be allotted to the next century. But the M.H.D. concept, comprising direct generation by the passage of hot gas through a magnetic field, is more promising. It opens up the possibility of discarding the boiler, turbine and alternator; fission may well prove highly suitable as a heat source. It is as yet only in the laboratory stage, but research supported by a number of utilities in the U.S.A. is yielding encouraging results. In a recent demonstration, 200kW of electric power was generated for a short period. A small beginning, no doubt, but the possibilities are clearly exciting.

Perhaps from the Scottish Highlands, pumped storage schemes will be delivering peak supplies to the Midlands, possibly by direct current transmission. Perhaps, if the word may be coined, a Euro-Electricity system will permit exchanges of energy throughout Europe, taking full advantage of the diversity between national peak demands.

The various possibilities I have mentioned can hardly be dubbed fanciful. No one, in 1920, could have foreseen the incredible developments which to-day we regard as commonplace. No one could have predicted with any confidence, even twenty years ago, the nuclear developments we know to-day, or the space travel which now seems increasingly possible.

Many more conjectures could be made, but, even though I am protected by the fact that there will be no discussion on my Address, it may be as well to journey no further. One thing, however, is certain. The youth now commencing his career in this industry will see even greater and more thrilling changes than those we have experienced since 1920. There will be no lack of fascinating problems, not only in research, but in the day to day practical applications of the most versatile servant ever possessed by mankind.

I concluded my Address in 1947 with the following words: "There is no foreseeable limit to the part electricity can play in assisting all forms of production, eliminating drudgery, promoting health and alleviating suffering, and innumerable other applications." They still seem to me an appropriate note on which to conclude in 1961.

Aircraft Research

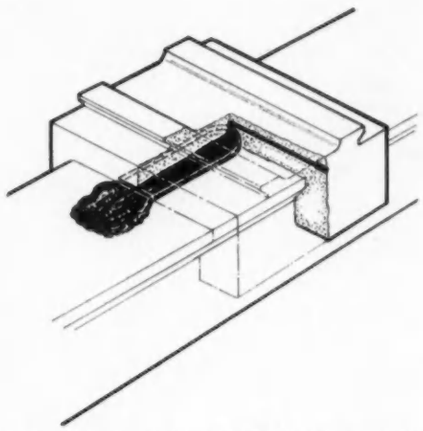
Friday and Saturday of last week were Open Days at the Royal Aircraft Establishment, Farnborough. Visitors were able to see a limited number of exhibits of scientific and technical interest and a demonstration of experimental flying.

THE Royal Aircraft Establishment, a part of the Ministry of Aviation, last week exhibited some of the work of its facility at Farnborough, Hants, for the first time since its Jubilee (see page 74, July 15, 1955).

A conspicuous characteristic of the work on show was a heavy emphasis on the narrow delta wing, evidenced by models ranging from free-flight all-wing gliders for aeroelastic measurement to small steel models with a half-cone fuselage to generate lift by interference for test in the hypersonic tunnel. This interest in the delta went so far that a display of possible future missile configurations consisted of shapes hitherto associated with " Nike " or " Falcon " rather than any British design. Among these many models at least two of the larger ones were based on the gull-wing design intended to minimise aeroelastic unloading (see page 405, September 2, 1960) but no results of lateral stability measurements were available. A quarter-scale model of the H.P. 115 narrow delta was displayed, accompanied by the information that the full-scale machine is expected to fly next summer; not until this flight will it be possible to decide whether landing such aircraft will be possible for human pilots.

Some work on the jet flap was displayed, with emphasis on the unexpected finding that the lateral stability was adversely effected, particularly for wings with high aspect ratio: dihedral and sweep-back could, experiments suggested, restore l_v to the stable range. There was also displayed a new idea applicable to jet-sheet pressure cushion vehicles, which are normally designed to be rather long and narrow in order to cut down the heavy energy losses as air passes through the forward and aft curtains ; this is to make the craft wider than it is long and propel it by turning the trailing sheet out instead of in, so that the machine becomes a jet-flap ram-wing. It was, however, made clear that the jet flap loses much effectiveness due to ground effects. Another study of the influence of the ground on an aircraft was being made on an apparently detailed model of the Hawker 1127, and it is perhaps worth recording that this model, in common with recent photographs of high quality, confirms our original report that no lateral control nozzles are fitted. It is of course widely believed that to investigate in a wind tunnel the behaviour of a vehicle moving over the surface of the earth it is necessary to simulate the absence of a boundary layer at ground level, and a design to incorporate a moving belt 8ft wide in a tunnel is being prepared.

The manufacture of models, always an excessively time-consuming process, is being tackled with numerically controlled machine tools, but so far the machine does no more than " dimple " the metal with numerous tool marks tangential to the required profile, leaving a very large amount of hand-work. A profile grinding machine is projected which should be able to follow curved paths with precision, and for this machine a new form of drive for the table is proposed. This, the " efflux drive," is effected by having on the bearing surface of the slide a recess which meets the boundary of the surface at the edge opposite the desired direction of travel. Oil is pumped into this recess at a point remote from the open end, and the viscous drag of the flow over the walls of the recess and the slide-way creates an unbalanced pressure tending to move the slide. The efflux drive is, clearly, inherently a constant force drive with a characteristic stable with respect to speed, but since the control elements are nothing more than the valves in the oil system, which can have very low inertia, it lends itself to an automatically controlled motion which is both " stiff " and smooth. Another obvious advantage is that the length of travel is virtually unlimited. The efflux drive has as yet been applied only to a carriage, located by hydrostatic bearings, on which the depth of the recess was held closely constant ; the propellant was continuously scavenged back into the system.



" Efflux drive " applied to the saddle of a machine tool

While there was very little work on guided weapons to be seen, the appropriate section appearing to be concerned with ballistic vehicles, it was interesting to note a number of designs of servo motors designed to run on hot gas, particularly the products of decomposition of iso-propyl-nitrate and of hydrogen peroxide. A research technique for investigating the directional stability of a high drag re-entry body shown was to launch a small model supported in a highly yawed attitude in sabots ; after separation it can be observed by the classical methods of ballistics.

A demonstration of experimental flying was also given ; it commenced with a flight by a restored S.E.5a, a design of the erstwhile Royal Aircraft Factory, which demonstrated ground strafing with the Lewis gun firing over the airscrew ; next a Hawker " Hunter " simulated an attack with rockets on a ground target. There then took off an Avro 707C research delta with dual control from side-by-side seats, the first pilot having the original manual flying control system and the second having electrical signalling to hydraulic position servos. The power system was designed to fail to neutral, control reverting to the first pilot. The intention is to elaborate the electrical signalling system to act as a combined auto-pilot and auto-stabiliser and render the control column a source not of commands, e.g. aileron deflection, but of demands, e.g. rate of roll.

A Blackburn " Beverley " then took off, without its rear doors, to demonstrate a new method of air-dropping stores with enhanced accuracy ; instead of the load descending for a rather long distance under a cluster of parachutes, it is mounted on a sled and dropped from a very low altitude, so that it hits the ground as soon as the greater part of its kinetic energy has been dissipated by the extractor parachute. In this case the load was of 3000 lb and the desired drop 50ft ; this height is clearly critical, since

The first example of the stainless steel Bristol 188 in the structural test rig: at a later stage kinetic heating also will be simulated

Civil passenger seating being tested on a rocket-propelled trolley arrested by a water squeezer

errors up or down increase the vertical or horizontal velocity at impact, and was monitored from flying control with radio telephony to the pilot. A succession of pilot, auxiliary and main parachutes dragged the load out of the open hull ; it landed in the intended area with considerable forward speed, but seemingly right way up. It can be imagined that this technique of air dropping might become valuable for S.T.O.L. aircraft with the ability to fly very slowly and therefore to drop from correspondingly low heights. A number of war loads placed on exhibition were ample evidence that present techniques of air dropping are savagely expensive and complicated : it may here be interpolated that there was demonstrated at model scale (with a hen's egg as payload) a technique for soft-landing under a parachute ; when the physical proximity of the ground is detected, an energy store (a spring in the model) is triggered which shortens the flying cables rapidly by separating a pair of pulley blocks over which they are reeved, thus decreasing the rate of descent of the load at the expense of that of the parachute.

The next item in the flying demonstration was a formation flight by a Bristol " Sycamore " and a D.H. " Chipmunk," the purpose of which was to investigate the gust response of the helicopter ; the gust response of the aeroplane is known, and thus the profile of the gusts encountered by the two machines can be inferred from its accelerometer trace.

There then took off a pair of Gloster " Meteor " jets, a Mk.VIII carrying a drogue target stowed in a container under one wing and a Mk.VII acting as a camera carrier to record the opening of the target. This type of towed target was devised to avoid the tricky operation of " snatching " a target from the ground, and consists of a banner ending in a wooden bar, around which it is wrapped for stowage, and 8000ft of nylon line ; the target is ejected from the carrier, which remains attached to the aircraft, and unfurls only when the line is at full stretch. Being almost entirely nylon, it can be dropped without danger before the tug lands ; it is rendered radar-reflective to assist in range-finding and assessment of results. The Mk.VII also made a photographic record of the dropping of a dummy man by parachute from an E-E " Canberra." The " Meteor " was occupied by a single pilot who must have exercised considerable skill to both fly his own machine and keep in the field of view of the camera objects dropping from other aircraft.

There also flew an Avro " Vulcan " B. Mk. I, which is employed on trials of bombs and bombing and has been equipped with automatic landing apparatus ; it flew over with the bomb doors folded back to show the large and deep cavity made possible with an all-wing structure. In the static park there was demonstrated the bombing-up of a similar machine with a carrier loaded with seven 1000 lb bombs ; bombs and carrier were supported on a simple trolley and lifted into the aircraft by the closing of four hydraulic jacks hooked on to strong points in the bomb bay. The jacks were energised by a mobile power pack on which, in contrast to an electrical " cart," the pump was dwarfed even by the compact Ford four-cylinder, side-valve engine.

A Gloster " Javelin " took the air, being a machine similar to one that has been in Singapore investigating at full scale the clearing of rain from windscreens ; the system adopted has a pair of jets of air, side by side, in front of the screen to break up large rain drops and a broad shallow air jet at the base of the screen to sweep the screen of the impinging small drops.

A " Beverley " of Royal Air Force Transport Command then dropped six parachutists, who demonstrated " sky diving " (falling freely in a controlled manner) down to 2000ft where they opened blank gore parachutes and headed for the aerodrome.

The final demonstration was by a Vickers-Supermarine " Scimitar " making a simulated nuclear attack on a ground target. The " over-the-shoulder " technique, in which the target itself is the reference point notified to the guidance computer, was used, as would be the case with, say, a ship at sea, the " Scimitar," flying fast over the target and gently pulling up into a large loop and roll off the top. This aircraft is also used to investigate the kinetic heating of externally carried stores at sustained high Mach numbers and the vibration of bombs due to the flow around the aircraft.

Can British Railways Pay?

At a Press conference last Monday, Dr. Richard Beeching, Chairman of the British Transport Commission, offered a preliminary analysis as he saw them, of the problems of the railways of this country. Apart from the development of commuter services which he felt could be made to pay and the maintenance of profitable main line passenger traffics, he saw salvation in the attraction back to the railways of general merchandise traffic. Studies have been started to see in what ways that objective could be reached.

Growth of the Problem

IN the past, whenever the future of the British railway system has been considered, its continued existence as an extensive national network has never been in real doubt. The only serious questions have centred around modifications and improvements. This was the position when the modernisation plan for British Railways was initiated. At that time the railways were just about paying their way, even though the whole system had been very much run down by years of intensive use under war and post-war conditions, without adequate replacement and maintenance. In the circumstances it is understandable that the view was taken that the railways must be renovated that renovation should be achieved by introducing modern equipment, and that the cost savings and service improvement which would result from this extensive modernisation of the system would make the railways profitable.

After modernisation was started, and up to the present time, the financial position worsened more than had been forecast and the upturn which was expected to result from completion of the earlier stages of modernisation did not develop. Over that same period, total passenger traffic was maintained at a steady level, but the total volume of freight traffic declined, mainly because of a fall in coal movement, but also due to a fall in general merchandise traffic, even though the total of such traffic in the country increased. Competition from other forms of transport developed strongly and, for this and other reasons, fares and charges did not keep pace with the rise in wages and in other costs affecting railway operations.

The existence of these very reasonable doubts about the potential future viability of a railway system of anything like the present size and pattern, at a time when British Railways are about halfway through their modernisation programme, presents me, as the new chairman, with very serious problems. The purpose of this note is to outline the view I take of the situation, at this early stage of my acquaintance with it, and the course of action which I think must be pursued.

Summary of Conclusions

My views are summed up below, and are amplified in what follows.

The financial difficulties of the railways, which have developed increasing losses over a considerable period of years, are due to deep-seated causes and will not be quickly eliminated. Losses may even get worse before they get better.

Although immediate economies are obviously of very great importance, and many steps must be taken to achieve them, it would be wrong to seek temporary cost savings at the expense of attention to root causes.

Important among the steps towards quick cost savings are more rapid elimination of redundant parts of the system and also of loss making traffics.

A worthwhile increase in revenue could be achieved, without unreasonable increases in fares and rates, if present restrictions were removed. Restrictions are, at present, distorting the pattern of traffic and artificially influencing the location of industry and population.

Doubts about the future of the railway system as a whole can only be resolved by a more thoroughgoing study of the present working and future prospects of the system than has been made so far. Such studies will take time.

It is now quite clear that the modernisation plan alone will not lead to viability. Unfavourable trends have developed more strongly and persistently than was foreseen when the modernisation programme was initiated. Nevertheless, drastic curtailment of the programme at this time would be a mistake, although the studies referred to above may well cause modification of its later stages.

The completion of some of the earlier parts of the modernisation plan has greatly improved the quality of some services. Further improvements will follow.

The modernisation programme provides for the modernisation of equipment and of the physical rail system. It is now necessary to modernise the managerial structure and the manner in which the system is operated in relation to a very different pattern of user requirements.

The key to the problem of the future viability of the mainline system is the possibility of radical modification of the services available for carriage of merchandise, and the attraction of a greatly increased volume of such traffic.

The Modernisation Plan

The view that the original expectations about the modernisation plan were optimistic does not mean that much of the programme ought not to be completed. I think it must be. Even if, upon more prolonged consideration, a railway system as widespread as at present is seen to have little prospect of future viability, it will not be possible to reach that conclusion and then to plan and provide alternative transport capacity very quickly. The railway system of the country is an asset of such potential importance and of such high replacement value that a continuing life of many years seems to be assured for most of it, even if its ultimate replacement is planned in the meanwhile.

To keep the rail system in being over that time a great deal of replacement expenditure will be necessary in any case, and failure to replace and modernise now will almost certainly lead to greater cost, in the form of increased operating losses, than the capital saving likely to be achieved by sharply curtailing modernisation at this stage.

Although there is no case for cutting off the modernisation programme because of present doubts about the long-term viability of the rail system as a whole, there is obviously a need for early decision as to what the true prospects for the system really are, so that later stages of the programme may be modified if necessary. In the meanwhile, projects will be considered to determine their relationship to any likely future plans.

The Key to Problem of Increasing Revenue

It is misleading to generalise about the system as a whole. It is made up of parts which do pay, parts which could clearly be made to pay, parts which are doubtful, and parts which certainly never will pay. Similarly, even in the broad groups into which traffic is classified, some traffics pay well, some contribute inadequately to fixed charges, and some cause direct loss

The London suburban lines and a large part of the predominantly passenger carrying Southern Region, as well as suburban lines feeding a few other large cities, will be required for as far ahead as it is possible to see. They will be needed, even if they are caused to operate uneconomically, and most of them could be made to pay.

The main uncertainty is focused on the potential viability of the main line network, plus a limited number of its more important feeding and connecting lines, which carry both the bulk of the freight traffic and the middle to long distance passenger services. The stopping trains on many of these lines, and services on a great many branch lines, are known to be uneconomic. These services have ceased to be the most suitable form of transport for the traffic for which they cater, and are likely to become even more serious causes of loss in future.

Uncertainty about the future of the main line network centres mainly around freight traffics, and, in particular, around merchandise traffic. It appears probable that revenue from medium to long distance passenger trains, which has kept up well so far, will be sustained and possibly increased as modernisation has effect. It is not to be expected, however, that passenger traffic will increase sufficiently to offset the loss of freight traffic which has occurred already, with a corresponding fall in its contribution to the fixed costs of the system. Therefore, unless freight traffic receipts can be considerably increased, the main line system will not pay.

Of the three main freight categories, other than parcels and mails by coaching trains only general merchandise traffic offers prospects of very considerable expansion. Coal and coke traffic has declined considerably of recent years, and the fall is likely to continue, both because the output of coal may continue to decline and because of a movement of some large consumers closer to the coalfields. Mineral traffic is likely to increase in step with growth of the economy, but the railways already have the major share of that traffic and cannot stimulate much more. Merchandise, the third main category of traffic, has in the past yielded about the same revenue as coal, but it has declined more than coal as a revenue earner in recent years.

The important points with regard to merchandise freight are :

(1) The railways share of the total traffic of this kind is small. Therefore large gains in volume are possible.

(2) The main freight movement system on the railways, while suited to coal and minerals for which it was developed, is not suited to movements of most merchandise traffics and the development of other forms of transport have made it unacceptable to many potential users. Therefore, large improvements in quality of service are potentially attainable.

The Studies Which Must be Made

The following studies must be completed as soon as possible :

(1) More detailed studies of the costs of handling existing traffics by existing methods, covering a wide variety of consignment sizes, terminal conditions, lengths of transit, &c.

(2) Determination of the forms of traffic which railways do handle, or could handle more satisfactorily and cheaply than other modes of transport.

(3) Studies of the pattern of traffic flows, both by rail and by other forms of transport throughout the country as a whole, to discover what volume of traffic favourable to rail is available and how it moves. These studies are particularly important, but also particularly difficult, in the case of merchandise traffics.

(4) Studies to determine how the railway system of freight handling could best be modified to attract the maximum amount of remunerative traffic.

(5) Studies to determine the volume of traffic likely to be attracted by various possible modifications of the system, and the potential profitability of the business so obtained.

Perhaps, in view of the obvious complexity of these studies, it is not surprising that I say they will take time. Nevertheless they must be made as quickly and as satisfactorily as possible. Only then shall we be able to forecast whether the railways as a whole can again become self-supporting.

Fares and Charges

Rail fares and freight charges are not high. Over many years they have increased less than cost factors which affect transport, less than prices generally, and considerably less than wage and salary levels. In many cases increase has been limited by competition, but in other cases artificially imposed limits have kept fares and rates below the level which would have been dictated by sound commercial policy. This artificial limitation of charges to levels which are low relative to costs and prices generally, applied to an organisation operating at a loss, results in an involuntary subsidy of unknown size and effect. It also falsifies the economic factors affecting the location of factories, offices, and population.

If present limitations are removed it will be possible to achieve a worthwhile increase in revenue and a more satisfactory pattern of traffic, without raising charges to levels which are unreasonable.

The Aims of British Railways

The main aims of British Railways must be :

(1) To bring the standard of their services to an acceptably high level.

(2) To operate services efficiently and economically.

(3) To make the whole business pay its way.

Neither the public, nor the railway staff, will be fully satisfied until all three of these objectives are achieved.

But for the financial stringency which results from present losses, success in pursuing the first two of these aims should be ours to command. It does not follow, however, that success in the first two respects will ensure achievement of the third aim, and some of the reasons why this is so have been enlarged upon in the body of this note. It is certain, however, that great improvements can and must be made.

LETTERS AND LITERATURE

Letters to the Editor

MILLIONS TO BE SAVED ?

SIR,—The Railway Development Association must be permitted to grind its axe, and I am content simply to abide by every word I have written; but it is incumbent on me, I suppose, to comment on a few of the items of misinformation in Mr. R. J. Harbach's letter.

He states that there is a capital liability that will accompany the railway system if it is taken over for conversion (though, according to his table, this liability will conveniently remain almost non-existent while the railways remain unconverted). He assesses the interest charges on it at £50,000 per mile per annum. On the 18,565-mile system that adds up to £928,250,000 a year, being the interest, at 5 per cent, on a capital liability of £18,565 million ! He has added in the date, or something.

Actually, as you explained in your article " Transport Reorganisation " on December 30, B.R.'s capital liabilities stand at less than one-tenth of that sum. The total is about £1600 million, of which £1200 million is in process of being accepted into the national debt proper, leaving £400 million to be carried by B.R. nominally, though in reality it will continue to be serviced by the taxpayer at a cost of about £24,000,000 a year. Presumably that is the origin of Mr. Harbach's £1500 per mile per annum charge on B.R., which is fair enough—conversion or no conversion—if one elects to job back, as I expressly elected not to. But that £50,000 per mile per annum of his ! On second thoughts, I dare say it was not the date, just an extra "0."

Then Mr. Harbach says that the capacity of a two-lane highway is reckoned at 9000 vehicles a day in England, giving a lane capacity of 250 vehicles per hour. The Ministry of Transport design figure is not 9000 but 6000 ; and in traffic engineering one does not deduce the hourly lane capacity from the daily capacity of the road : if one attempted to do so one would never presume the day's flow to be uniform over eighteen hours.

Highway capacities are not wholly relevant anyway, for we are considering the railways converted into a motor road system, not into ordinary public roads. This motor road system will be intermediate in character between a motorway system and a highway system ; and, of course, it will vary. In parts, notably along the main multi-track suburban and inter-city lines it will be of motorway standard ; in other parts, along minor lines, it will more nearly resemble the highways. Along these minor lines, chiefly, there will be found many of the features that are commonplace on the highway system, including crossroads that were formerly level crossings. As crossroads they will become very much less of an obstruction ; moreover 82 per cent of them are merely occupation crossings, not public crossings ; the routes and cross-routes on which these features will be met are very unlikely to be sufficiently heavily trafficked to justify the expense of grade separation, though that refinement will always be available if perfection is required. To offset these features it should be remembered that there is one respect in which the converted railways will be superior even to the motorways. They will be virtually horizontal. Coaches and lorries designed specially for use on them could comprise a totally new genus of motor vehicle : conversion would open up a new era for motor transport.

T. I. LLOYD

Guildford,
June 12, 1961.

Book Reviews

Pacific Steam : The British Pacific Locomotive. By MARTIN EVANS. Percival Marshall and Co., Ltd., 19-20, Noel Street, London, W.1. Price 12s. 6d.

" THE steam railway locomotive is a machine which has a strange fascination for many of us, an enthusiasm for it is something which is generally acquired very early in life and seldom lost however long we may live, however many other interests may take our attention in later life."

Fortified by these thoughts, as expressed in his preface, the author has presented in this book the story of the British " Pacific " type steam locomotive, and we may say at once that a perusal of its pages has given us much pleasure and satisfaction. The author has in our view offered a well-ordered and concise account of the development of the " Pacific " type as conceived by notable designers of the past for passenger service on British railways, commencing, of course, with G. J. Churchward's engine, " The Great Bear," designed and built for the Great Western at Swindon in 1908, and terminating with the " Pacific " locomotives built for British railways to meet the requirements of R. A. Riddles, the last of our long and distinguished line of steam locomotive engineers, some of whose work is ably dealt with in the intervening pages of a book which will become a valued possession of many readers.

Not all the numerous " Pacific " type express locomotives built have been outstanding successes. " The Great Bear," for example, had but a limited sphere of usefulness and later Sir Vincent Raven's examples of the type do not appear quite to have measured up to expectations, and Oliver Bulleid's engines, while notable in many respects and capable of doing excellent work, suffered somewhat in certain details of their make-up. Of all the " Pacifics " built for our railways, those due to Sir Nigel Gresley, built at Doncaster as long ago as 1922, will no doubt be awarded pride of place by many who read this book. Certainly the fact that even to-day many of Sir Nigel's own creations, all, be it noted, based on the original conception of 1922, are still at work will lend support to those who have an admiration for these locomotives. The chapters devoted to these locomotives do them the justice they deserve. The somewhat heterogeneous collection of Doncaster " Pacific " designs which followed in recent years form the subjects of a succeeding chapter.

Passing on to the Stanier " Pacifics " built for the London, Midland and Scottish Railway, the author again presents a good account of the development of the type, commencing with " The Princess Royal," completed at Crewe in 1932, and terminating with an account of the much larger " Duchess " class, which appeared in 1937.

When discussing the Crewe-built engines, attention is also given to the " Turbomotive" No. 6202, which was ultimately reconstructed as a four-cylinder locomotive of " The Princess Royal " class, modified with respect to the cylinder arrangement, which followed along the lines adopted for longer " Duchess " class locomotives. As rebuilt, this modified engine came out late in 1952, carrying the name " Princess Anne," and we are rather surprised this engine, the last of the Stanier type " Pacifics," has escaped notice. Unfortunately, this engine had an exceedingly short life, being completely wrecked in the deplorable accident at Harrow on October 8, 1952, only some eight weeks after the engine left the Crewe Works. The Bulleid " Pacifics," both as originally turned out and subsequently rebuilt, form the next chapter, which, like those preceding, is well written. We wish, however, that the author would not describe the locomotive mechanical stoker as an automatic stoker, which it is not. All the stoker does is to deliver the coal to the firebox, where it is deposited on a table just inside the fire door ; from thence it is distributed over the grate, as required, by steam jets under the control of the fireman, while the rate at which coal is fed to the firebox is governed by the speed of the two-cylinder, reversible, self-lubricating engine operating the conveyor mechanism.

British Railways " Pacific " designs form the subject of the concluding chapter. The author adds much to the value of the book by including some particulars of the working of these engines, generally based on the results of official trials which, we may add, have also appeared from time to time in our own pages. In the concluding paragraph of a Foreword, R. A. Riddles writes : " I am sure that all those who have the affection of the steam locomotive at heart will find Martin Evans' *Pacific Steam* of great interest and historical value." We share this opinion. The book is well written, the illustrations are excellent and the presentation by the publishers leaves nothing to be desired.

Kinematics and Dynamics of Machinery. By ROBERT L. MAXWELL. Prentice-Hall International, Inc., 28, Welbeck Street, London, W.1. Price 45s.

THIS book, like many others from America, was intended originally for use in undergraduate courses at a particular university, in this instance Tennessee, where the author is Professor of Mechanical Engineering. It will be considered here in relation to the needs of British students. As correspondence in this journal has sometimes shown, many in this country are dissatisfied with the way in which " Theory of Machines " has been and is being taught. In the attempt to get away from the treatment which often leaves the student unable to see the principles for the ironmongery, it can be difficult to find a

textbook which both gives the student the principles in a form he can understand, and shows him how they are applied to engineering problems. This book should go far towards solving the difficulty.

The title accurately describes the contents which, after an introduction as brief as it is clear, fall into four groups. Ten chapters on kinematics start with the motion of a point, and cover degrees of freedom, constraints and mechanisms, instantaneous centres and their use in velocity analysis, velocity diagrams and acceleration diagrams. Commendably, acceleration analysis is extended to simultaneous sliding and rolling contact in cam systems, which are also dealt with by the more common method of equivalent mechanisms. A useful chapter discusses the relative merits of various methods of kinematic analysis.

One chapter deals with static force analysis, including friction. The funicular polygon is explained (though not very clearly, to one reader at least) and is used considerably in later dynamic analysis. Frictional forces are considered only as incidental (pin joints, &c.); devices depending on friction for their operation are not covered.

Eight chapters on two-dimensional dynamics cover translation and rotation of rigid bodies, work, energy, impulse, dynamic analysis of machines, balancing (at some length), critical speeds, and an extremely brief chapter on gyroscopic effects. The final four chapters (cams, gearing, gear trains, and flywheels and governors) show how kinematic and dynamic considerations must be combined in the design of these items. There is a good index, and each chapter concludes with problems well chosen to make the student understand what he is doing.

The material is roughly that given, under various titles, to first and second year students of mechanical, electrical and aeronautical engineering. In its general plan and in many details too numerous to mention, the book seems to reflect its author's determination to think about the subject from first principles, and it should encourage the same desirable habit in students, while reminding them that ultimately engineering is concerned with real machines. In a book which covers so much of what a student needs, it is perhaps a pity that vibration appears only incidentally ; many students would benefit from realising that vibrations is a branch of dynamics and not really a separate subject.

Beside the many commendable details, there are some which are unfortunate. The definition given of a vector includes quantities which in this country at least are not regarded as vectors ; several not very useful methods of velocity analysis are given in detail before the most generally useful one ; the development of expressions for the acceleration of a point seems more involved than the use made of it justifies ; D'Alembert's principle is used without his name ; an ingenious and helpful treatment of shaft whirling depends on ignoring bearing friction and considering air resistance as both significant and viscous. Possibly the most serious criticism is that products of inertia and principal axes are not mentioned. Although the book is, properly, concerned only with two-dimensional work, one feels that in these days it is wrong to send students into the world knowing nothing of the limits within which their two-dimensional dynamics is true. When these criticisms are seen in their proper proportions, the book can be commended in the confidence that students (and practising engineers) will find this part of engineering science explained clearly and helpfully.

Railway Works Construction. By H. M. PEARSON, B.Sc., A.C.G.I., A.M.I.C.E., F.R.E.S. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 35s.

IN producing this much-needed book the author has achieved success in a difficult task—that of explaining the basic principles of strength of materials and elementary structural design in a manner which can be easily understood by supervisory construction staff having a somewhat limited knowledge of mathematics and engineering science. It is then shown, by numerous typical examples of railway structures, how these theoretical principles are applied in practice, both in steel and concrete construction. There is much wisdom in this and if inspectors and gangers realise that there are sound reasons for carrying out a certain job in an approved manner there is a better chance that such a procedure will be adopted. A very useful section of the book deals with the examination of existing structures, the detection of defects and the methods of dealing with them. Detailed advice is given regarding inspection procedure and the organisation of reconditioning and reconstruction works ranging from comparatively simple examples such as minor defects in drainage and earthworks to such major jobs as the renewal of bridge girders.

This part of Mr. Pearson's informative book can well be studied with interest and profit by assistant engineers as well as by inspectors and clerks-of-works. Further useful chapters deal with the preparation of reports, specifications, estimates and contract documents.

The book is based on the author's long experience of railway civil engineering and its careful study cannot fail to increase the efficiency of supervisory staff engaged on railway maintenance, whether attached to the district engineers' offices or employed by contractors.

Theory and Application of Mechanical Engineering Measurements. By MARK B. MOORE. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 51s.

THIS book consists largely of descriptions of the elements of measuring instruments and testing devices used in mechanical engineering. The first six chapters (out of the total of twenty-six) include some useful numerical examples to be worked out by the reader. There are some introductory remarks on the basic philosophy of measurement and as the author intends to " stimulate and guide creative thinking " he has evidently deliberately left the reader to think out his own detailed procedure in using any measuring device.

He stresses the importance of care in presenting reports but probably slightly overstates his case when he says that " The engineer with a ' gift of gab ' or the ability to present an attractive report will usually get further than a better engineer who is unable to express himself effectively." Potential readers of reports will no doubt take this to heart and any potential report-writer who suspects that his readers may have done so will feel that his problem is one stage more difficult than this author's remarks would imply. He will try to find out something about the abilities, limitations and psychology of his most influential reader ; one of his difficulties will be to decide whether to use the faintly Oriental closure " Respectfully submitted " that this book seems to favour. The book is eminently readable and includes a list of references to other American books with similar titles.

Books Received

Microwave Antennas. By A. Z. Fradin. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 105s.

Coal. By Wilfrid Francis. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 147s.

Microwave Ferrites. By P. J. B. Clarricoats, Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 50s.

Foundation Failures. By C. Szechy. Concrete Publications, Ltd., 14, Dartmouth Street, London, S.W.1. Price 21s.

Principles of Semiconductors. By M. G. Scroggie. Iliffe Books, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 21s.

Modern Arc Welding. By J. A. Oates. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 30s.

The Conquest of Space. By Albert Ducrocq. Putnam and Co., Ltd., 42, Great Russell Street, London, W.C.1. Price 30s.

Gases at High Densities and Temperatures. By Yu. N. Ryabinin. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 25s.

The Adventure of Engineering. By David Jackson. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 21s.

X-Ray Metallography. By A. Taylor. John Wiley and Sons, Ltd., Gordon House, Greencoat Place, London, S.W.1. Price 216s.

Linear Algebra. By G. Hadley. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 6.75 dollars.

British Nuclear Power Stations. Rolt Hammond. Macdonald and Co., (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 25s.

A Guide to Technical Writing. By C. Baker. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 15s.

Essentials of Dielectromagnetic Engineering. By H. M. Schlicke. John Wiley and Sons, Ltd., Gordon House, Greencoat Place, London, S.W.1. Price 76s.

Aids to Machine-Shop Practice. By C. T. Bower. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 18s.

The Technical Illustrator. By Hubert Cook. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 35s.

Aircraft Electrical Practice. By Lewis F. Wainwright. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 45s.

Essentials of Heat. By O. M. White. Cleaver-Hume Press Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 15s.

The Manager and the Organisation. By Eric Moon. Tavistock Publications, 11, New Fetter Lane, London, E.C.4. Price 21s.

Dictionary of Mechanical Engineering. By Alfred Del Vecchio. Peter Owen, Ltd., 50, Old Brompton Road, London, S.W.7. Price 42s.

Surveying. Fifth Edition. By W. Norman Thomas. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 40s.

Equitable Payment. By Elliott Jaques. Heinemann Educational Books, Ltd., 15-16, Queen Street, Mayfair, London, W.1. Price 35s.

Guide to Belgium and Luxembourg. Ninth edition. By C. A. Thompson. Belux Publications, 26, York Road, Holland-on-Sea, Essex. Price 6s.

Gears-Spur, Helical, Bevel and Worm. By P. S. Houghton. The Technical Press, Ltd., 112, Westbourne Grove, London, W.2. Price 63s.

The Management of Innovation. By Tom Burns and G. M. Stalker. Tavistock Publications, 11, New Fetter Lane, London, E.C.4. Price 30s.

Nuclear Energy Simplified. By John Ernest Radford. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 28s.

Statically Indeterminate Structural Analysis. By R. L. Sanks. The Ronald Press Company, 15 East 26th Street, New York 10, N.Y. Price 10.00 dollars.

British Miniature Electronic Components and Assemblies Data Annual 1961-62. Edited by G. W. A. Dummer and J. Mackenzie Robertson. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 80s.

Mechanical Measurements. By T. G. Beckwith and N. Lewis Buck. Addison Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 66s.

Prestressed Concrete Simply Explained. By H. Kaylor. Contractor's Record, Ltd., Lennox House, Norfolk Street, Strand, London, W.C.2. Price 28s.

Mathematical Puzzles and Diversions from " Scientific American." By Martin Gardner. G. Bell and Sons, Ltd., York House, Portugal Street, London, W.C.2. Price 17s. 6d.

Dumpers

The system of tractor/trailer combination developed by Shawnee-Poole, Ltd., was described in this journal at the time it was introduced into this country, in our article on the Public Works Exhibition of 1958, published in THE ENGINEER of November 7 of that year. The company has now introduced a new, smaller, model—the FD535—which we illustrate ABOVE, and which consists of a 5 cubic yard rear-dump trailer drawn by a standard Fordson "Dexta" tractor of 32 b.h.p.; alternatively, the trailer can be flat-decked for haulage of timber or general duties. The basic invention on which the system depends is the coupling between tractor and trailer, which allows articulation in three planes, yet applies the load from the trailer to the tractor below and slightly ahead of the tractor's rear axle (in the illustration the lowest element in the coupling is a "V"-shaped drawbar which extends forward to pins suspended by straps at the rear axle. A more complete description was given in our previous article.) The weight of the trailer thus acts to stabilise manoeuvres made by the tractor, and this is the reason why a load of 6 tons can be handled by a prime mover of only 32 b.h.p. and weighing about one-fifth of the payload. In fact, the design is such that the front wheels of the tractor will lift if the load sticks, and the tractor can then be steered by its brakes; this lifting occurs apparently only in bottom gear at around maximum drawbar pull, and the geometry of the linkage is such that the restoring couple increases as the front wheels lift, and 21 deg. is the highest inclination possible. In the static condition the weight distribution is as follows:

	Drive axle	Steering axle	Rear axle
Empty, lb	3,391	1,344	4,200
With 13,400 lb load, lb ...	6,639	1,484	14,252

The trailer has air brakes, there being a compressor mounted on the tractor, and is equipped with a reservoir so that the brakes operate when the tractor engine has been switched off. A pair of hydraulic jacks lifts the body of the tractor to tip the load, and a "restrictor" protects the jacks from extension should the raised trailer be backed against a heap of tipped material.

We understand that the Shawnee-Poole system is to be extended for application to other standard agricultural tractors beside the Fordson, and French and Spanish factories are soon to start production. A training school for salesmen has been started by the company, with the aims of making clear that the unorthodox pay-load/horse-power ratio is due to the engineering characteristics of the coupling; and thence how the cost savings of around 50 per cent claimed for the system can be substantiated in any particular case by work study and costing.

The new Northfield F.7 dump truck has a nominal capacity of 7½ cubic yards and a 25,000 lb pay-load. Its maximum speed on the level is 28 m.p.h. The large "spotting area" of the hopper (8ft. by 10ft) encourages fast loading, and double-acting hydraulic side rams effect a total tip of 78 deg. in seven seconds. The front and rear sections are hinged vertically to give a steering pivot through 180 deg., and horizontally to allow 30 deg. relative movement between two axles. Front wheel drive and weight distribution placed well forward (never less than 55 per cent over the driving wheels) and a low centre of gravity are features of the machine. The final drive transmission incorporates disc parking brakes, totally enclosed. Power is from a Ford 6D engine, developing 96 b.h.p. at 2250 r.p.m. and driving through a Brockhouse torque converter. The final drive unit incorporates fully floating axles and uses standard Fordson "Major" parts. The hydraulic pump is driven from the power take-off of the torque converter. The machine is manufactured by Northfield Industrial Fabrications, Ltd., and George Cohen, Sons and Co., Ltd., are the selling agents.

International Construction Equipment Exhibition

No. I

The first International Construction Equipment Exhibition opened at the Crystal Palace in South London yesterday, and will remain open until June 24. Its aim is to present a comprehensive display of equipment for the building and civil engineering industries, and it is noteworthy for its 25-acre open-air site where plant can be seen in use at two proving grounds, as well as on the various exhibition stands.

A NEW exhibition was opened yesterday in London, at Crystal Palace. It has been promoted by Construction Equipment Exhibitions, Ltd., a newly formed company financed by: The Federation of Manufacturers of Construction Equipment; the National Federation of Building Trades Employers; the Federation of Civil Engineering Contractors; and Industrial and Trade Fairs, Ltd. Its object is "to present the most comprehensive display of equipment for the building and civil engineering industries ever assembled on one site, so that everyone concerned in the constructional industries in this country and overseas, from the most modest jobbing builder to the biggest civil engineering contractor, will find among the range of exhibits plant and equipment to satisfy his particular requirements." There are in the region of 200 exhibitors, and the scale and layout of the exhibition generally indicate that a promising start has been made at this first exhibition towards achieving this ambitious object. The intention is to hold further exhibitions, possibly at yearly intervals. This year, a very good representation of British firms in this field has been achieved, but it appears from the list of exhibitors and the advance notices we have received that there are only a handful of foreign firms, notably German ones, plus, of course, various British agents for foreign equipment, to justify the title "International." However, this conclusion may prove deceptive, and the organisers state that fifty foreign firms are represented at the exhibition.

The justification for holding the exhibition is to be found principally in the recent history of growth of the industry. Its output has increased fourfold in value over the past ten years, and is expected to surpass £100 million for the year 1961. Almost exactly half of this output is exported. The need for a show-place for overseas publicity, and also for an exhibition with generous space and above all with a proving ground for plant, were additional factors.

The exhibition occupies a 25-acre site at the Crystal Palace, which includes 200,000 square feet of space set out as two proving grounds to demonstrate equipment in action. The facilities at the Crystal Palace site are exceptional. This is the first exhibition to be held there since before the war, but plans have now been drawn up by the London County Council for redeveloping the whole of the 200-acre estate, and restoring it to its former glory as a centre for recreation and instruction, and it is likely, therefore, that this exhibition will be the first of many to be held there.

The organisers point out that the International Construction Equipment Exhibition is unique in that it is sponsored by both manufacturers and users. Certainly, a very extensive range of plant of all kinds is to be seen. In the ensuing descriptive notes, which are based on advance particulars received from exhibitors, we have not attempted to give a comprehensive or even a representative account of the exhibition, and our aim has been limited to selecting a few examples from the multitude of plant and equipment to be seen at the exhibition, which appear to be new models or to possess special engineering interest.

Frederick Parker, Ltd.

Amongst the exhibits shown by manufacturers of the largest types of constructional plant, the display of Frederick Parker, Ltd., may be taken as a typical example of the exhibition as a whole. The central exhibit is the firm's "Starmix" 37 mobile asphalt mixing plant which has a batch capacity of 1 ton. Other exhibits include the firm's Mk. 3 paver, to which several improvements of detail have recently been made, and the small concrete mixer known as the "Mini-Giant," powered by a diesel engine; the mixer costs more with the diesel power, but a saving in running costs is claimed.

The heading illustration, left, shows a mobile crushing plant which is one of a range of six similar plants made by Parkers. The plant illustrated is a model 5006 "Rock Ranger" which produces an "all-in" crushed material. It consists of a plate apron feeder and a 30in by 18in "Rock-sizer" crusher with bar screen between feeder and crusher. A similar but larger machine also on show at the exhibition is the 1109 Mk.II "Crush-Ranger" which has an output in excess of 200 tons per hour. It will handle pit-run sand and gravel or form a secondary unit to a primary rock-crushing plant. Either "all-in" material is produced or up to three separate products, sand, "all-in" material, and a sized stone.

Butters Brothers and Co., Ltd.

An interesting mobile crane, now being manufactured in this country by Butters Brothers and Co., Ltd., at its works in Hillingdon, Middlesex, is designed to provide an economic versatile machine quickly and easily adaptable for a number of different operations. This "Manipult" machine can be seen arranged in its crane form in Fig. 1. It is carried on a rigid frame supported on two pneumatic wheels with a smaller castor wheel at the front and a jack, which is lowered for stability at the rear when at work. A 6 h.p. air-cooled petrol engine used to power the machine is stated to require only 1½ gallons of fuel in a normal working day.

When used as a mobile crane with a 14ft 6in jib, the machine is capable of lifting 16 cwt to a radius of 10ft and 12 cwt load out to 15ft radius. A 12ft fly jib can be fitted to the normal jib to give an extra over-reach, which is useful for vehicle loading. When required for grabbing duties, the machine is fitted with an arm device which enables considerable force or purchase to be applied to the tooth grab. The machine can also be used with a 47ft high tower and fly jib to lift up to 5 cwt at 12ft radius.

Drive from the engine is transmitted through lever-operated clutches to the various motions and all the controls are within convenient reach of the operator standing on a small platform on the rotating structure.

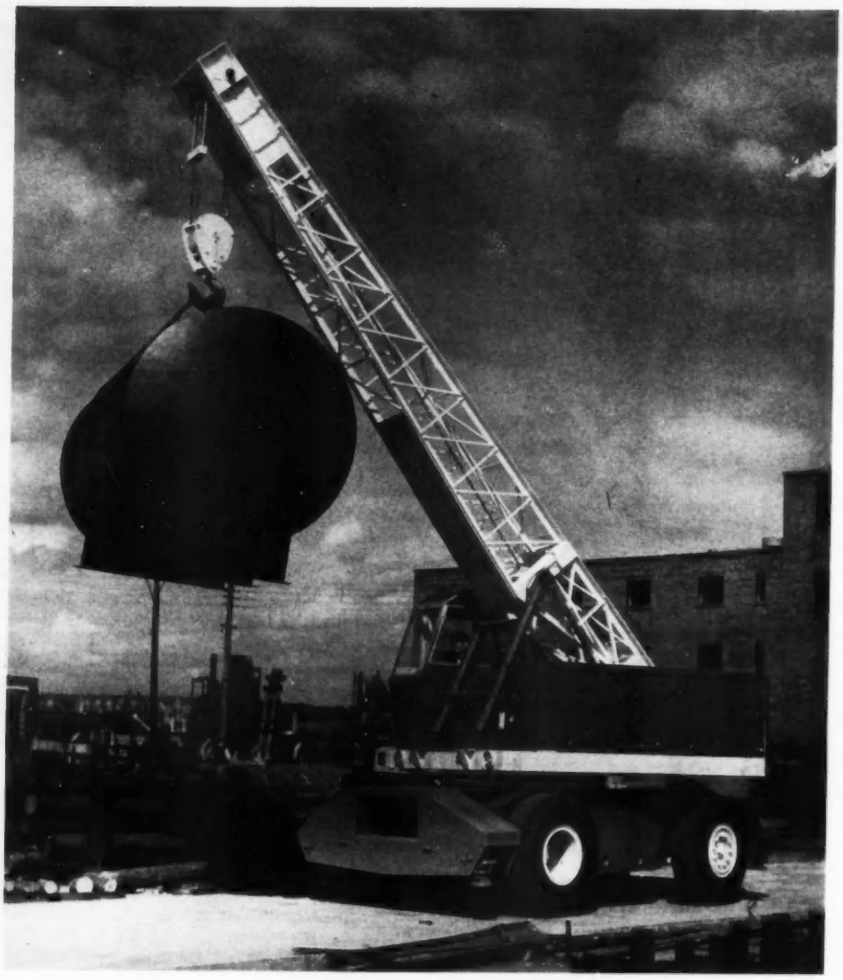
Construction Machinery, Ltd.

A self-loading dumper shown by Construction Machinery, Ltd., Wakefield, is simple to operate and has a wide range of application. As can be seen in our illustration, Fig. 2, lift arms supporting the shovel are positioned on the outside of the hopper truck body, with the shovel working beyond the tailboard. To load, the shovel is lowered, filled in the usual way, and lifted so that the full load can be tipped into the rear portion of the body, subsequent loads being brought progressively towards the front, until the body is filled. The operator sits on a swivel seat and has duplicate controls enabling him to load, swivel round and drive the vehicle away without turning or involved manoeuvring. The dumper is powered by a Leyland diesel engine developing 100 h.p. at 2200 r.p.m., and driving through a 16in single dry plate clutch. The constant mesh transmission has five high and five low gears, giving a ten forward and reverse speeds, from 2·13 m.p.h. to 32·6 m.p.h. The loading bucket has a nominal capacity of 1 cubic

Cranes

The nine cranes exhibited by Steels Engineering Products, Ltd., include the largest diesel-electric truck crane made by the firm. This crane, the "Valiant" ABOVE RIGHT, is claimed to be the largest machine of its type manufactured. It has a lifting capacity of 55 tons at 12ft radius on the standard 50ft centres strut jib. The standard 50ft lattice jib can be extended to 140ft using extension pieces and the maximum jib length available to 240ft, using a 40ft fly jib. The diesel-electric transmission employed on the crane follows normal "Coles" practice and consists of a variable voltage generator which is driven by an 11.3 litre A.E.C. diesel engine and supplies current to each of the separate electric motors of the hoist, derrick and slew motions. All motions are reversible and can be operated either individually or simultaneously.

The chassis is a heavy duty eight-wheeled, four-wheel drive crane carrier having a frame fabricated from rolled steel beams and plates. It is powered by a six-cylinder Rolls Royce diesel engine developing 250 b.h.p. at 2100 r.p.m., power being transmitted through a 20in fluid drive to a gearbox with eight forward and two reverse speeds. Gear selection is by a pneumatic, semi-automatic system. Pedal-operated pneumatic brakes act on all wheels and a handbrake acts on the rear wheels only. Hydraulically power assisted steering provides easy control of this large heavy duty machine.

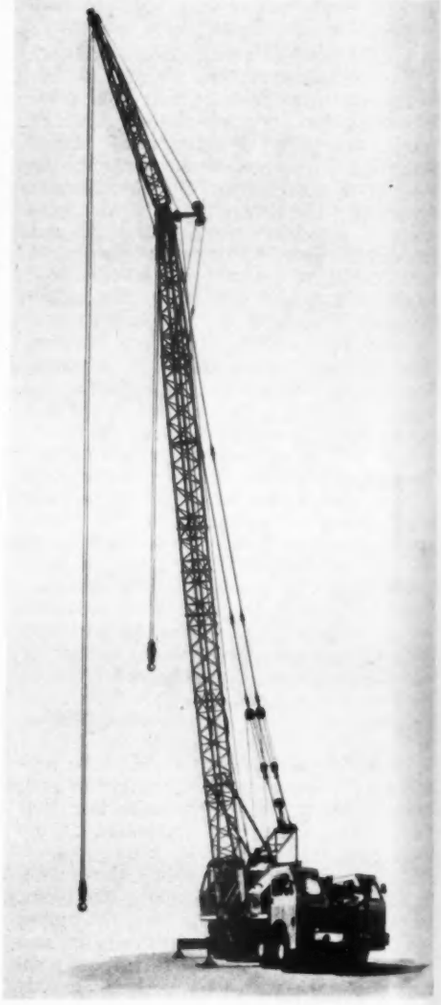


The "RapieR 1520" mobile crane, ABOVE, shown by Ransomes and Rapier, Ltd., which can be supplied with either "strut" or "cantilever" jibs, is exhibited with a 60ft strut jib. The basic length of this strut jib is 30ft and it is extended by adding 10ft and/or 20ft inserts to give a maximum length of 80ft. Cantilever jibs, such as that shown on the crane in the illustration, are made in basic lengths of 20ft and 30ft, and either 5ft or 10ft bolt-on extensions are available. A 50ft jib is obtained by adding a 30ft braced extension to a basic 20ft jib. Steering of this machine is air-assisted and a high degree of manoeuvrability is obtained from a steering lock of 45 deg. of the inner wheel which gives a turning circle radius of 21ft 6in. The crane has travelling speeds on pneumatic tyres up to 7 m.p.h., and has a diesel-electric drive with separate motors for the hoist, derrick, slew and travel motions, all controls being situated in the driver's cab which gives a good all-round vision.

A new truck-mounted crane, BELOW RIGHT, exhibited by Priestman Brothers, Ltd., Hull, is based on the "Lion" crawler mounted excavator/crane. The crane superstructure is powered with a 75 b.h.p. Dorman engine, and a maximum load of 60,000 lb can be lifted at a speed of 16ft per minute on eight falls of rope at 12ft radius. The sectioned pin-jointed, quickly assembled 30ft lattice boom can be increased in length by adding sections to 100ft and will take 20ft to 30ft fly jibs to give a total boom/jib length of 130ft when a maximum load of 10,000 lb can be lifted at 37ft radius with a jib head pin height of 132ft. Provision is made for lifting over boom point and jib point simultaneously if required.

The crane is operated by light Westinghouse controls with three-lever operation for lifting, slewing, rapid boom hoisting or lowering, and power lowering under load. Large capacity foot brakes control quick load lowering under gravity (the switchover from power to gravity lowering is instantaneous) and in conjunction with power-lowering, give precise down movement control of the load. An automatic "throw-out" prevents over-derricking whilst an air-operated auxiliary swing damper controls boom/load momentum and holds the superstructure firmly in any position for load placing.

The machine is mounted on a Foden F.C.20 eight-wheel crane chassis powered by a Gardner 150 b.h.p. engine driving through twelve forward and three reverse speeds. The vehicle has a joist main frame which, with heavy duty jack beams in position at 16ft centres, provides a generous margin of stability.



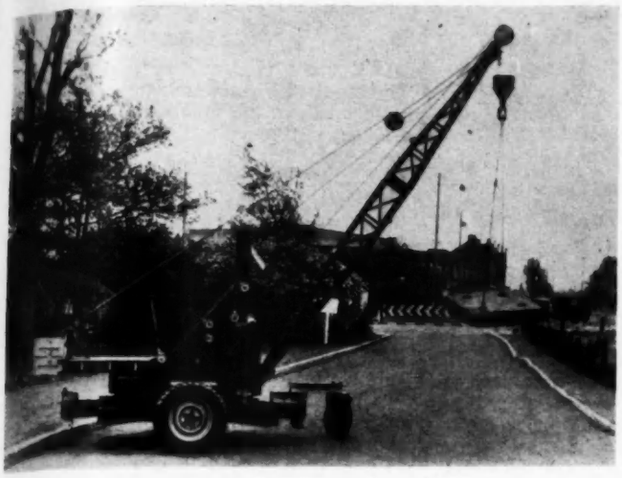


Fig. 1—Small mobile crane adaptable for lifting, grabbing and other duties

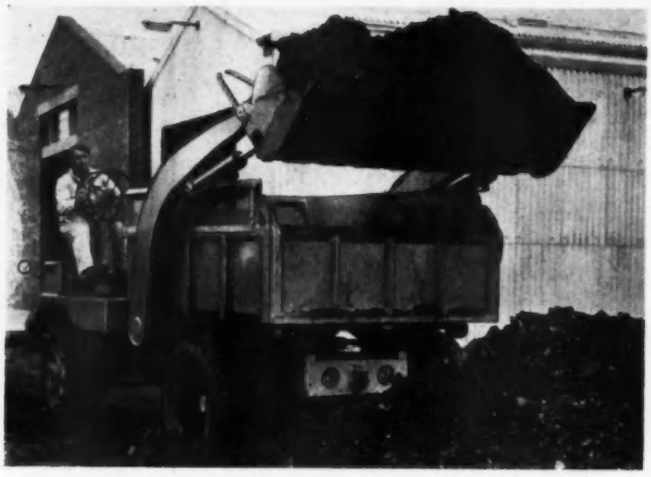


Fig. 2—Self-loading dumper

yard. The 5½ cubic yard capacity tipping body has a tailgate fitted with a catch, which is automatically released when the load is to be discharged.

The two-way steering is power-assisted and air brakes are fitted to the front and rear wheels of the machine. Large capacity double acting hydraulic rams are used for operating the lifting arms and bucket movements. When dumping, the tipping of the body is positively controlled through a linkage actuated by hydraulic rams. The machine has an overall length with the bucket down of 21ft 2in, and with the bucket up, 15ft 10in, its overall width being 8ft.

Ransomes and Rapier, Ltd.

One of the principal exhibits of Ransomes and Rapier, Ltd., Ipswich, is the 9 cubic yard truck mixer shown in Fig. 3. The mixer drum is driven by a hydraulic motor to which fluid is supplied by either of two hydraulic pumps — one driven from the front of the truck engine and the other from the gearbox power take-off. Through a hydraulic control valve, operated from the discharge end of the machine, the drum rotation can be quickly reversed for discharging and a fuel control lever varies the speed of the drum.

The mixer has an unmixed batch capacity of 12½ cubic yards and can agitate a batch of 11 cubic yards of premixed concrete. Charging is simple and, with the drum revolving at full speed, it can be loaded in about two minutes. A special blade configuration at the mouth of the drum discharges its contents when the direction of rotation is reversed. A long swivelling chute, normally used in discharging the mix, can be swung out of the way for direct delivery of concrete into dumpers or skips. Mixing water is sprayed into the drums under pressure from the measuring water tank by a 1½in pump driven by a separate hydraulic motor.

The firm also exhibits the crane illustrated on page 992, and a 6in pump. The pump has a capacity of 80,000 gallons per hour and has a fully automatic self-priming action which gives a quick prime and large air capacity. These pumps are stated to run for long periods without attention, and they are capable of handling dirty water containing up to 25 per cent solid matter in suspension.

George Cohen 600 Group, Ltd.

A new mobile crane in the "Jones" series, made by K. and L. Steelfounders and Engineers, Ltd., of the George Cohen 600 Group, Ltd., is the "Sitemaster," which has been developed to meet the demand for mobile plant that relies upon heavy, large diameter tyres to allow movement at speed over rough sites. This machine is derived from the "KL 66" standard mobile crane with a four-wheel differential drive. The diesel mechanical drive system has been retained in this machine, but the standard power unit has been replaced by a heavy-duty diesel engine developing 62½ b.h.p. and the slewing superstructure is carried on a special heavy chassis reinforced to withstand the considerable stresses imposed by travel over rough terrain. This chassis allows the fitting of wheels with 14.00 by 24 tyres inflated to 65 lb per square inch to give a good cross-country performance.

It is claimed that the machine can negotiate all but the deepest mud and traverse other rough or loose surfaces with comparative ease. Gradients up to 1 in 5 present no obstacle and the crane travels on more reasonable surfaces at speeds up to 6 m.p.h.

The "Sitemaster," like the standard "KL 66," is a fully slewing machine with a lifting capacity of 6 tons at 10ft radius. The basic jib length is 30ft and sectional lattice jibs can be supplied to give greater lift heights when required. Hoisting speed is 118ft per minute (single fall) and the maker's design of precise lowering is provided, allowing effective handling of precast materials, positioning of steelwork and other jobs calling for precise control.

Other equipment to be seen on this firm's stands include Pingon tower cranes, loaders, compressors, and the 7½ cubic yard dump track illustrated on page 990.

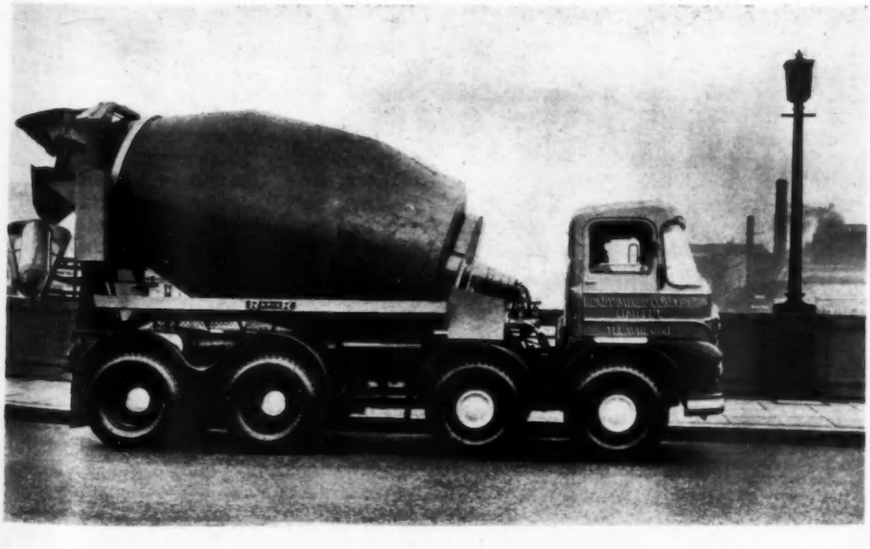


Fig. 3—Truck mixer of 9 cubic yards capacity, with hydraulic drive to the mixer drum

Euclid (Great Britain), Ltd.

Rear dump trucks from 15 to 27 tons capacity, motorised scrapers of 7, 14 and 24 cubic yards capacity and a crawler tractor are to be seen upon the stand shared by Euclid (Great Britain), Ltd., Motherwell, and that firm's distributors in the United Kingdom, Blackwood Hodge and Co., Ltd.

The 24 yard twin power scraper made by this company, which has a heaped capacity of 32 cubic yards, is powered by two 290 h.p. Cummins engines. Each engine drives through a torque converter and has a semi-automatic power shift transmission, the drive being taken on through differentials which proportion the power to the wheel to suit the traction. Speeds up to 35 m.p.h. are available. A 14 cubic yard machine has a heaped capacity of 20 cubic yards and is generally similar to the 24 cubic yard scraper. It is powered by two 140 h.p. Leyland diesel engines, one at the front and the other driving the rear wheels.

(To be continued)

The Municipal Task

This week the Institution of Municipal Engineers has been holding its eighty-eighth annual conference at Brighton. Apart from an active technical programme and representation at the conference of the International Federation of Municipal Engineers, the meeting aroused especial interest because of the vote, due to be taken on Tuesday last, on the proposal for amalgamation with the Institution of Civil Engineers. Here we print abstracts from the address of the new President, Mr. J. H. Melville Richards, borough engineer of Harrow, which he delivered on Wednesday. Mr. Richards' address was, of course, prepared in advance, and we aim to report the result of the vote in our next issue.

AFTER long and tedious negotiations, which at times seemed almost interminable, this Institution did agree with the Institution of Civil Engineers on a form of procedure, designed to ascertain the views of our respective members as to whether or not the two Institutions should unite. Both Institutions sent out a referendum in the form of a questionnaire, or voting paper. It will be remembered that the voting resulted, in the case of our Institution, in a total poll of 83·6 per cent. Just over 3000 voted for amalgamation out of 6000 who had a right to vote, and just under 2000 were against. This constituted a majority in favour of amalgamation of 62 per cent of those voting.

It is generally conceded that there is a need for an overall body to speak with one mind for the engineering profession as a whole. This has always been apparent and there are several ways by which it might be achieved. It is, of course, a matter of opinion as to which is the best.

One body of opinion advocates amalgamation with the Institution of Civil Engineers. Then there is the alternative proposed by the President of the Institution of Structural Engineers, Lieut-Colonel Kirkland, as outlined by him in his presidential address at the annual dinner of that Institution on May 5. He made the suggestion that the "Mother" institution, the Institution of Civil Engineers, should be diverted from "take-over bids" and the like, and should encourage her varied offspring, and admit their spokesmen to her Council on the basis of proportional representation. He suggested that members of all the chartered engineering institutions should describe themselves simply as "Chartered Engineers." This, of course, is another suggestion.

Others feel that a new sort of organisation in the form of a Federation would better serve chartered engineers as a whole. They believe this would achieve the necessary strength and representation while each individual Institution would still keep its identity in its specialist field and enjoy the privileges of its own Royal Charter, together with the protection and representation afforded by the Federation to which it would belong and as a corporate body subscribe.

They envisage a Federation which would speak with one voice on behalf of itself and all its confederate institutions, and to which no eligible chartered institution would hesitate to belong.

This, in their opinion, is a better solution than the idea of being the one and only Institution to be absorbed as a fractional part of the Institution of Civil Engineers involving the abandonment of a charter which was granted only thirteen years ago.

This body of opinion hopes that our great engineering profession as a whole, representing some 150,000 chartered engineers (who are members of the many Institutions enjoying that Royal Privilege) will in this way get together and form such an independent Federation to "Father" all their common policy and interests.

Engineers and Civilisation

The environmental engineering services are the backbone on which a high standard of living depends—and they are all too often taken for granted. The underdeveloped countries expect to build in ten years what has taken the older countries fifty. More or less overnight they hope to raise their people's standard of living. The fulfilment of all these hopes is dependent on the very limited supply of municipal and other engineering manpower. From bitter experience in this country we know that professional engineering manpower is a scarce commodity. The annual capital investment of local authorities, amounting to £612 million for 1960, represented some 15 per cent of the nation's capital investment of £4079 million and yet this is one of the sectors most starved of two essentials, first engineering manpower and secondly the necessary financial resources.

It is generally understood to-day that although there are many desirable projects which local authorities wish to undertake there is still the economic argument that many of these projects are in competition for the same engineering manpower and resources. Some hard thinking is required in order to formulate a set of priorities. There is also the important overall allocation of these resources between the public and private sectors of the country's economy. Both manpower and capital require to be so distributed between the public services and private industry as to achieve a maximum rate of increase in the standard of living.

At the present time municipal engineers have a feeling that the more obvious, popular or spectacular projects receive a greater share of manpower, resources and attention from the central Government than they may in fact deserve if the aim of a rapidly rising standard of living is to be achieved. The environmental services such as a first-class system of motorways, the planning of our towns to cope quietly and efficiently with the enormous volume of traffic which we know from our present experience will continue to increase, for every family will shortly be able to afford a car and some will have two or more (*sic*). Then there is the cleaning of our rivers and estuaries; the massive tasks of slum clearance and urban renewal—all these are the fundamental necessities which ought to receive a high priority in the allocation of resources. Investment in these projects will yield not only monetary returns in terms of reduced costs of road transport, saving in time and such like advantages, but also in the special terms of the general standard of living and ability to enjoy the other developments which with technical science we are setting out to achieve.

Public Policy and Consultation with Engineers

There is a tendency for engineers not to be consulted in some of our major projects until much of the policy has been decided. Engineering activities are now on such a vast scale that surely this state of affairs does not fit in with the needs of society.

The impact of municipal engineering services on the background of modern living is so great that local authority engineers should collectively be brought into consultations in the highest quarters at the earliest stages so that their experience can be available to help shape public policy and thereby avoid waste of effort and misapplication of professional manpower.

This does not mean that the municipal engineer thinks that he knows better than everyone else, but he has a great contribution to make as a part of the policy-making team. This is not a criticism of the most co-operative engineers in the Ministries with whom the municipal engineer deals daily, but a suggestion to the Government, and those who formulate public policy that the representation of the municipal engineer and indeed the Ministry engineers on governmental inquiries, and public commissions and committees, is not nearly high enough to reflect their importance in relation to the enormous total annual expenditure incurred on engineering works in the local government service. If there are to be changes of emphasis in any of these major sectors of capital investment, then surely they could be influenced for the public good by an earlier contribution to policy from the municipal engineering profession.

Once again it would appear that one reason for late consultation has been that the investment of capital in public service engineering only produces benefits which are not immediately obvious and are often social benefits of an intangible nature. They are background services on which all others depend. A new factory produces immediate visible results and whenever this should happen to be a new car factory (a fundamental of a high standard of living), then we soon suffer physically from its products in our congested towns. This only serves to emphasise that first we must renew our road system and provide a modern network for the vehicles by careful planning for all this new traffic. Perhaps this is one of the best examples of the vital necessity of the background municipal engineering services upon which all the material products and comforts of modern society depend.

The major problems facing us to-day in municipal engineering are planning for traffic; the provision of modern urban and national road systems; urban redevelopment and the clearance of slums; and finally the provision of new sewerage and sewage disposal schemes which in some cases will be of great size. The necessary qualified professional staff must be made available to deal with these vast problems. The Institution has a constantly increasing intake of students each year, yet the manpower available is still insufficient to deal with the problems before us. Adequate and worthy salaries must be paid to the experienced men in the middle ranges, on whom the brunt of the design work falls. These are the men who are yielding to the temptation to leave the public service and go into more remunerative professional work in industry and abroad. If our traditional and magnificent local government engineering services are to be maintained and improved then serious thought must be given to raising the status and salaries of these all-important officials.

Reform in Local Government

There are many reforms which could, with advantage, be put into effect in the field of local government, and without going into detail I would suggest, at the outset, a closer liaison at national level between ourselves and the town clerks, treasurers, medical officers and those responsible for education. It is my intention, during the coming year, to inaugurate approaches to such people through our Institution and also to approach the association of local authorities regarding specific reforms which could, by friendly co-operation, be put into effect for the benefit of local authorities generally, and their officers in particular, with a view to the better streamlining of procedure, and the further improvement of relations between officers, local authorities and government departments. By such means it may be possible to eliminate many administrative difficulties.

If some of these obstacles can be overcome the local government service will be more attractive to those seeking employment in it, and to those who seek election as councillors.

Details of how this can be achieved will need to be worked out but I believe that here lies a great field for co-operative effort and for joint discussion and research on many problems concerned with the administration of our local affairs, the exploration of which should lead to a speeding up in the carrying out of works by the removal of certain obstacles to progress with which we are all too familiar.

It is not my purpose to elaborate on this subject to-day, but merely to hope sincerely that there will be a hearty response from the other parties involved when we put forward our proposals with the best intentions in the world, because something really must be done to improve conditions in local government, if local democracy as we understand it in this country, is to survive.

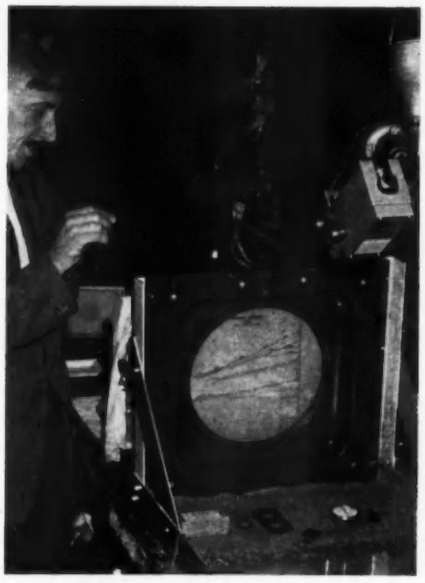
Airway Telecommunications Engineering

AFTER the Ministry of Transport and Civil Aviation was formed, a small establishment was set up in 1946 at Mitcham, Surrey, for the installation, test and repair of radio and radar equipment for civil airports and traffic control centres. Later, this unit was moved to Yeading, Middlesex. In 1947 a unit specifically for the maintenance and inspection of G.C.A. radars was established at Blackbushe Airport, Surrey, and was subsequently expanded to deal with longer-range radars. Finally, on May 1, 1959, a Telecommunications Engineering Establishment was formed by the Ministry of Aviation, and it was decided to locate it in new premises at Gatwick to serve as a base headquarters from which the staff could in future conduct their work. These premises were opened officially by Mr. Geoffrey Ripon, M.P., Parliamentary Secretary, Ministry of Aviation, on June 6. They comprise an office and workshop block, and a radar experimental building, on the opposite side of the A.23 road to the present airport, adjacent to the old Gatwick Airport terminal building. The office block is a two-storey building 300ft long by 39ft wide, connected by covered linkways with the single-storey workshop block, 300ft long by 160ft wide. Also a single-storey structure, the radar experimental building is 82ft by 37ft on plan. Its floor is raised 2ft above normal ground level to house the numerous electrical services required. Two electrical substations have been provided for the site. Consulting engineers to the Ministry were Frederick S. Snow and Partners, the consulting architects were Yorke, Rosenberg and Mardall, and the main contractor was Carlton Contractors, Ltd., Carlton House, Epsom, Surrey.

The work of the establishment is divided among six sections concerned respectively with planning, progress and contracts; precision approach radar; radar surveillance; communications; navigation aids; and radio and general workshops. While much apparatus for radio and radar installations is necessarily purchased from contractors, its assembly and adaptation to individual site requirements are undertaken in the establishment, while laboratory tests determine suitability and may lead to further development for specific purposes. Duties of the workshops include the manufacture of furniture in small quantities for individual airports, although where quantity production is required this is carried out by contract. Examples seen during a visit to the establishment on June 6 were operating consoles and air traffic controllers' desks, with accessories such as flight progress boards.

Experience at Blackbushe with the maintenance of ground controlled approach radars led to redesign proposals from which was evolved the precision approach radar now being constructed at the establishment. A console was seen ready for tests before dispatch to Ringway Airport, Manchester, and is shown in an accompanying illustration. The two display tubes are for ten-mile and two-mile ranges, and each has projected on it an image of the approach and runway pattern in elevation and azimuth. The patterns are projected from slides in the units mounted above the tubes. A procedure for slide production has been developed at the establishment in which the original drawing is made on a plastic mould which reproduces the curvature of the tube face. The second illustration shows how the two patterns appear on the tube. Another development at the establishment has been a five-channel switching equipment enabling traffic controllers to select outputs from different radars, such as 25cm and 10cm equipments, for presentation on their desks. The control timebase for this integrating facility has been designed by the unit.

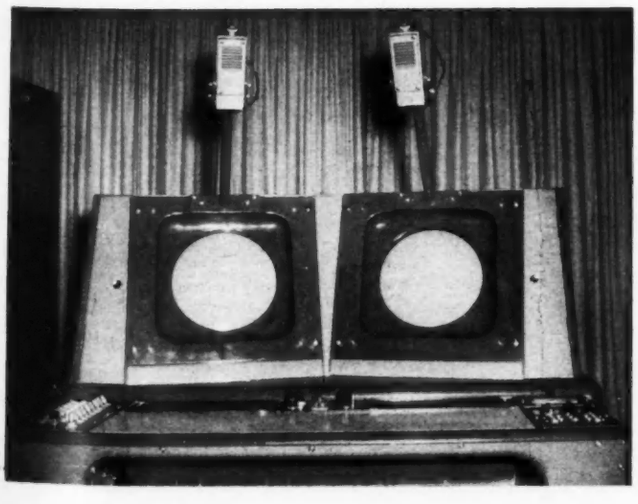
During last winter the unit installed six terminal V.O.R. equipments required to enable B.E.A. "Viscount" aircraft to operate to airfields in the Western Isles. While primarily a homing facility, this network is found useful for fixes by cross-bearings because of the rapidity with which the aircraft receiver can be switched to take consecutive bearings from three beacons. The range of a terminal V.O.R. is some 30 to 50 miles and the present programme is based on this pattern rather than the longer-range airways V.O.R. The number of airports to be equipped is expected to provide adequate fixing coverage.



Elevation and azimuth patterns projected on to precision approach radar tube

The communications section is concerned with ground radio transmitters of a wide range of powers, going up to some 10kW or 15kW for working with airports in distant parts of the world. Many forms of transmission are involved, such as frequency-shift keying, teletype, and a residue of c.w. with hand-keying to a few Eastern destinations. A network of v.h.f. links is maintained enabling controllers to communicate on this band with aircraft flying in any part of the country by remote transmission. There are also microwave links for transmitting radar information. Although the provision of landlines, teleprinters and telephone services is normally undertaken by the Post Office, close liaison is maintained in the design of desk units, remote control systems and other matters where special consideration must be given to civil aviation requirements. The establishment is engaged on the development of transistor circuits for control purposes hitherto fulfilled by valves.

Among work seen in the laboratories was an improved signal-level monitor with automatic transmitter changeover switching for non-directional m.f. beacons, standing wave tests in connection with surveillance radar feeders, the development of high-Q cavity resonators for multi-channel working on a common aerial, and tests of a recently introduced commercial miniature cathode ray d.f. equipment for controllers' desks. Work is in progress on "talk-through" apparatus for installation in ground mobile units to give conference facilities by radio telephony.



Two-tube console with slide projectors for precision approach radar developed by the Telecommunications Engineering Establishment

SHORTER REPORTS

Birthday Honours

THE list of the Queen's Birthday Honours, which was published on Saturday, June 10, includes awards as follows to engineers and those engaged in the engineering and allied industries :

Baron—General Sir Brian Hubert Robertson, chairman of the British Transport Commission, 1953–61.

Baron, Life Peer—Rt. Hon. Alfred Robens, chairman, National Coal Board.

Baronets—Sir John Maxwell Erskine, deputy chairman, North of Scotland Hydro-Electric Board.

Knights Bachelor—Mr. W. K. G. Allen, chairman and managing director, W. H. Allen, Sons and Co., Ltd.; Mr. J. F. Baker, Professor of Mechanical Sciences and Head of the Department of Engineering, University of Cambridge ; Mr. S. Barratt, chairman, Albright and Wilson, Ltd.; Mr. A. G. Clark, chairman and managing director, Plessey Company, Ltd.; Mr. R. S. Mactier, lately chairman, General Council of British Shipping and Liverppool Steamship Owners' Association ; Mr. H. E. Snow, a deputy chairman and managing director, British Petroleum Company, Ltd.

C.B.—Mr. A. Wolstencroft, director of radio services, General Post Office.

C.M.G.—Mr. C. T. Henfrey, lately chief engineer, East African Railways and Harbours.

G.B.E.—Sir Ivan Arthur Rice Stedeford, chairman and managing director, Tube Investments, Ltd.

K.B.E.—Sir Lawrence Edwards, chairman and managing director, Middle Docks and Engineering Company, Ltd.

C.B.E.—Mr. C. F. Barnard, executive vice-chairman, Mirrlees, Bickerton and Day, Ltd.; Mr. W. L. Burns, chairman, Henry Balfour and Co., Ltd.; Captain R. E. Cowell, R.N.R. (Retd.), marine superintendent, Peninsular and Oriental Steam Navigation Company ; Mr. A. Dean, assistant general manager, North Eastern Region, York, British Railways ; Mr. W. A. Fairhurst, senior partner, F. A. Macdonald and Partners ; Mr. W. L. Francis, director (grants and information) headquarters, Department of Scientific and Industrial Research ; Mr. D. H. Kendon, chairman, Merseyside and North Wales Electricity Board ; Mr. A. F. Lampitt, managing director, Telephone Cables, Ltd.; Mr. L. F. C. Northcott, principal superintendent, materials and explosives division, Armament Research and Development Establishment, War Office ; Mr. E. Norton, research director, Yarrow and Co., Ltd.; Mr. F. W. Page, director and chief executive ; aircraft division, English Electric Aviation, Ltd.; Mr. W. H. Penley, deputy chief scientific officer, Royal Radar Establishment, Ministry of Aviation ; Mr. C. A. Risbridger, chief engineer, City of Birmingham Water Department ; Mr. N. H. Searby, manager, guided weapons department, Ferranti, Ltd.; Mr. G. A. Whipple, chairman and managing director, Hilger and Watts, Ltd.; Mr. F. C. Williams, Professor of Electrical Engineering, University of Manchester.

Sheffield–Leeds Motorway

THE proposed route for the 34-mile long Aston–Sheffield–Leeds Motorway, from M1 through the industrial area of the West Riding, has been published by the Ministry of Transport. A viaduct ¾-mile long will take the motorway over the built-up industrial area of the Don Valley between Sheffield and Rotherham ; seventy-six other bridges are planned to take the motorway over or under existing roads, railways and canals. The proposed line of route has been surveyed by West Riding County Council whose county engineer is Mr. S. Maynard Lovell. It branches north-westwards from the proposed Crick-Doncaster extension of the M1 at Aston-cum-Aughton, passes between Sheffield and Rotherham and through the outskirts of Barnsley and Wakefield to end just south of Leeds. Junctions with main roads crossing the route are planned to serve traffic between intermediate towns such as Sheffield, Rotherham, Barnsley, Pontefract, Huddersfield, Wakefield and Bradford. At a future date, the motorway is also intended to connect with the proposed Lancashire–Yorkshire Motorway. The draft scheme will be open to inspection for the next three months at the offices of the various local authorities through which the route passes, and during that time, any person may make representations to the Minister or lodge objections.

Radio Engineers' Dinner

REPLYING to the toast of "The British Institution of Radio Engineers" at a dinner at the Savoy Hotel, London, on June 8, the President of the Institution, Admiral of the Fleet Earl Mountbatten of Burma, surveyed the future of computing and telecommunications techniques. The demand now, he said, was for computers having a much larger storage capacity without unduly increasing their size. In physical design transistors eased the problem of bulk, while high-speed storage was being improved by the development of very thin magnetic films. There remained the problem of securing easier identification of densely stored data. Progress in this direction, for which techniques which might prove suitable already existed, would enable language translation techniques to be improved, and eventually a speech typewriter to be developed.

Dealing with communications, Earl Mountbatten said that unless some unforeseen and significant break-through ocurred in techniques, the future of global communications lay in the use of satellites as relay stations. The present pressing problem of growing demand on existing channels was not confined to plain communications. He expected that the merchant mariner and the civil aviator of the future, like their Royal Navy and Royal Air Force colleagues, would be navigating with the aid of special satellites. It was envisaged that the satellites would issue instructions to the navigator on demand, which would give the corrections he had to apply. This would call for an extensive radio system and a large number of calculations made by computers to keep the satellite fed with the constantly changing correction figures. He believed we should be forced to active satellite repeaters, certainly in the case of navigational and meteorological satellites.

With regard to the fighting services, he was particularly interested in the integration of their communications networks, since it seemed obvious that no single defence service or civil department could afford to put its own satellites into orbit.

Miniature Pressure Transducer

A DIFFERENTIAL pressure transducer developed by the Instrumentation Department, Royal Aircraft Establishment, Farnborough, for plotting static and dynamic pressures on wind tunnel models, has been introduced by New Electronic Products, Ltd., 360, Kennington Road, London, S.E.11, an affiliated company of Honeywell Controls, Ltd. The transducer is applicable to many fields of investigation and design, owing to its very small physical dimensions of only $\frac{3}{8}$in by $\frac{1}{4}$in by $\frac{1}{8}$in. Operation is on the variable capacity principle. Two chambers are separated by a diaphragm which deflects under pressure, varying the capacitance between itself and two insulated electrodes. Zero drift is less than 0·15 per cent per deg. Cent.; rise time is fifteen micro-seconds, with a high carrier frequency. Two pressure ranges are available, ±4 lb per square inch and ±10 lb per square inch. Others are under development.

The transducer is used in conjunction with an a.c. bridge with close-coupled inductance ratio arms, a carrier amplifier, and a phase-sensitive demodulator. The voltage output of ±4·5V, developed across an impedance of 5000 ohms may be applied to any suitable indicator or recorder.

[Reply Card No. 1032]

Control Console for S.S.B. Radio Equipment

CONTROL facilities for up to twelve single-sideband radio transmitters and twelve receivers over Post Office lines some 10 miles in length are provided by the console illustrated, the design and production of which were undertaken by the Electronics Division of The General Electric Company, Ltd., Coventry. The console has been supplied to the Admiralty Surface Weapons Establishment for installation at a Royal Naval Air Station, to provide ground-to-air communication.

Either one or two operators may be employed at the console and each can select transmitter or receiver channels independently by means of key switches. Loudspeaker monitoring facilities are available, or each channel may be individually selected for the headphone circuits ; alternatively a mixture of any number of channels may be preselected and fed to the headphone circuits. "Channel call" indicator lamps show which receive channels are calling.

The voice transmission circuits are equipped with automatic gain control amplifiers to ensure full modulation of the transmitters under all conditions of use, and facilities are provided for speech clipping to be switched in as an aid to long-range voice communication. This circuitry, which is built into the console, provides more power to the speech waveform without over-modulating the transmitter, resulting in better intelligibility of weak signals. Moving-coil, electromagnetic or noise-cancelling microphones may be used according to circumstances.

Any remote receiver may be brought exactly into tune by the operation of one of twelve fine-tuning keys on the console ; a tuning motor operates through reduction gearing to give fine control of the local oscillator frequency at the remote receiver. Comprehensive metering and testing facilities are included in the console, and all radio-frequency control and metering circuits are fully transistorised.

[Reply Card No. 1025]

Two-position console for remote control and monitoring of single-sideband transmitters and receivers

B.S.A. Centenary

ALTHOUGH the B.S.A. Group of Companies is now well known for a variety of products ranging from machine tools to motor-cycles and from special steels to coal preparation machinery, the Birmingham Small Arms Company was founded in June, 1861, to do just what its title stated—to make small firearms—and nothing more. But at the time it was a concern with a difference, for it proposed to make guns by machinery, a project which was not viewed without some suspicion. Birmingham already had a respectable tradition in gunmaking and an enviable reputation for its products, but the trade was entirely in the hands of individual craftsmen and was organised on an almost incredibly complicated system of sub-division of work. Nevertheless, gunmaking by machine was already a success in America, and the British Government gun factory at Enfield was also using machines to make military rifles from interchangeable parts. If Birmingham was to retain its military gun trade, it had to have machines, and it was a group of "traditional" gunmakers which raised £50,000 of capital to launch the new venture.

Technically the project was a success. The factory made first-class weapons and soon gained for the company the high reputation it has held ever since. Small arms have never ceased to be made by B.S.A., and to-day its subsidiary, B.S.A. Guns, Ltd., is an internationally-known producer of military and sporting guns. Financially, the project was rather more uncertain, and it became apparent after a few years that it was unwise to be dependent upon a single product, demand for which fluctuated wildly with the political situation. By 1878 matters had been brought to a head by a shortage of orders which led finally to the entire factory being closed for a time. A small contract for Martini-Henry rifles enabled the management to start the factory again, but it was obvious that something had to be done for the future, and in 1880 the answer was found in the bicycle.

This was the company's first essay in product diversification. It paid, and it was not the last. From then on B.S.A., though remaining faithful to its original product, kept it in its proper perspective, and took the opportunity, from time to time, to branch out into other lines. How far this has gone is obvious from a list of the company's present-day products—a list which at first sight may appear to have little logic about it. Yet the reverse is the case. There is much in common between some of the components of a bicycle and a gun. From pedal cycles to motor-cycles is an obvious step, and as the company found it necessary to design and make many of its own machine tools and small tools, it was a logical development to put these goods on the market. Again it was an obvious move from motor-cycles to motor-cars, and the purchase of the pioneer Daimler Company in 1910 was a good way to break into the trade. Guns, cycles, cars and machine tools need high-quality steels—hence the purchase of the Jessop-Savile steel works in 1920. So the story could continue. Some branches of the business have been bought as an extension of the older branches, or as a source of component or material supply. Some, like the precision alloy castings, powder metallurgy and industrial plating branches, have sprung from research into new and better ways of doing things.

But if it is important to know when to take up a new line, it is equally necessary, for business success, to know when to drop an old one. B.S.A. has been faced with this problem in the past, and has met it in the only reasonable way. The Daimler business is a good example. Over the years Daimler had built up a reputation for high-class luxury cars. Changing social conditions reduced the market for such cars, and the emphasis fell on the mass-produced popular vehicle. To attempt to enter this market against the competition of the established producers would have been foolish. There was only one thing to do, and B.S.A. did it, reluctantly, but logically. The business was sold to a buyer who needed the factory and equipment primarily for another purpose. There have been other prunings in the history of B.S.A., but it is by pruning that the plant is kept healthy. B.S.A. has never hesitated to cut out the dead wood while at the same time developing and extending other branches when opportunity arose.

Light alloy sheets up to 8ft wide can be annealed on this G.W.B. furnace

High-Powered Induction Heaters

THREE induction heaters of higher power than equipment previously supplied have been added to the range of Delapena, Ltd., Tewkesbury Road, Cheltenham. All models have a nominal output frequency of 150 kc/s ; the E 75 and E 100 have continuous output ratings (to B.S.S. 1799) of 75kW and 100kW respectively, while the E 75/100, with a continuous output of 75kW, is also capable of intermittent operation at up to 100kW output with one-minute stand-by intervals, so long as the average output does not exceed 75kW. For operating with a wide range of inductors and workpieces, high and low impedance output terminals are provided. Optional accessories are an external voltage-regulating transformer enabling output power to be varied over a range of 16:1, push-button control of power-factor capacitors, and built-in water cooling for the r.f. tank-circuit, output transformer and inductor.

[Reply Card No. 1038]

"Flash" Annealing of Aluminium Alloy Sheets

CONTROL of grain size in light alloy sheets —especially those used for deep drawing—is important, and for this purpose G.W.B. Furnaces, Ltd., Dibdale Works, Dudley, Worcestershire, pioneered the "flash" annealing furnace. In this furnace the metal is heated to the required temperature in the shortest possible time and means are provided for ensuring uniform conditions, both throughout the individual sheets and throughout the complete charge. A furnace on this principle has been installed at the Woodgate, Quinton, Birmingham, works of Birmetals, Ltd., to anneal sheets produced by the Sendzimir cold rolling mill.

The furnace, which is of the forced-air circulation type, electrically heated, will take sheets up to 8ft wide, or two 4ft sheets side by side. It has four heating zones, with a total electrical loading of 600kW, and the nominal throughput is 2 tons per hour, though in production throughputs well in excess of this figure have been achieved. The dimensions of the furnace are : loading length 6ft, heating chamber 40ft, cooling chamber 70ft, unloading length 6ft, width 8ft 6in. The temperature range is from 150 deg. to 550 deg. Cent.

Sheets are loaded by hand on to rubberised balata ropes which form an entry conveyor, and are conveyed through the heating and cooling chambers by heat-resisting steel strip conveyors. At the delivery end the sheets pass to a second rubberised balata rope conveyor, from which they are unloaded by hand and inspected on both sides prior to moving to the dispatch bay.

Heating is by electric elements of 80/20 nickel chromium strip suspended from the roof of the heating chamber and separated from the charge by heat-resisting steel baffle plates. Eight two-speed centrifugal fans circulate the heated air within the furnace, and a system of baffles ensures that the heating is uniform. A refractory brickwork lining, with a graded insulation backing, reduces heat losses from the heating chamber to a minimum. Cooling is also by forced air circulation, in this case from fans and cross ducts running above and below the sheet conveyor, with slots to allow the air to flown uniformly over the sheet surfaces.

[Reply Card No. 1039]

First International Conference on Timber Engineering

TIMBER roof construction will be the principal subject to be discussed at an international conference to be held at Southampton University from September 18 to 23. It is intended that this should be the first of a series of such conferences, held from time to time in different countries. The first three days of this conference will be taken up by discussion of a number of papers, grouped under the following headings : "General Problems of Timber Construction"; "Structural Timber Joints"; "Some Structures of Particular Interest"; "Testing Timber Structures"; "Timber Shelf Structures"; "Some Constructional Problems"; "Economics and Comparisons." Each group of papers will be introduced by a prominent engineer. The Conference is being organised by Dr. H. G. Allen, at the Department of Civil Engineering, Southampton University, and the final date for the return of application forms is August 1.

Klystron Oscillators

Two klystrons have been announced by Elliott-Litton, Ltd., a member of the Elliott-Automation Group, 34, Portland Place, London, W.1. The K-band (1cm wave-length) reflex klystron, type 12RK4, has been developed for use as a pump source for parametric amplifiers and masers and is capable of a minimum power output of 350mW over a 5000 Mc/s tuning range. The construction makes this klystron suitable for airborne applications.

The second klystron, 4TFK3, is a high-power tunable oscillator for the 68–80 Mc/s (4mm) band and has a tuning range of approximately 2000 Mc/s. Average power output over the band is 500mW. The valve operates as an harmonic generator, with Q-band (36–46 Mc/s) floating drift tube bunching cavity. The resonant cavities are water-cooled.

[Reply Card No. 1040]

SHORTER REPORTS *(continued)*

Self-Instruction Device

INSTRUCTION in electronics is being given to airmen of the U.S. Air Force at the Keesler base, Missouri, by a self-training apparatus known as the " AutoTutor." The device was developed by the Western Design and Electronics Division of U.S. Industries, Inc., and is now being introduced in this country in a simplified form for quantity production by U.S. Industries Inc. (Great Britain), Ltd., New Bond Street House, London, W.1. This Mark II " AutoTutor " (illustrated) will be manufactured by the Burtonwood Engineering Company, Ltd., Warrington, Lancs., a subsidiary of U.S. Industries Inc. (Great Britain), Ltd.

Instruction is presented to the user by projection on to the screen of script and diagrams contained in 35mm film. The projection system and electro-mechanical film-traverse mechanism are inside the cabinet. Each " lesson " frame of the film concludes with questions and a series of possible answers, one of which is correct. The answers are identified by letters of the alphabet corresponding with nine of the lettered push buttons on the right of the screen. When the student has selected an answer and pressed the corresponding button, the film advances a certain number of frames, and the frame then displayed either confirms that the answer was correct, or explains why it was wrong and directs the student to return to the lesson frame by pressing the " R " (return) button. Film traverse is at the rate of twelve frames per second.

Confirmation of a correct answer is accompanied by the next stage of the lesson, which may introduce a new principle or provide a further test

Technical training device with built-in projector for filmed lesson scripts

on what has just been learned. The sequence of frames on the film is arranged so that a student cannot " skip " a step of instruction, since it is only by returning to a lesson which has been misunderstood, and supplying the correct answer, that he finds the key to reaching the next step. Errors are recorded automatically on a counter inside the instrument.

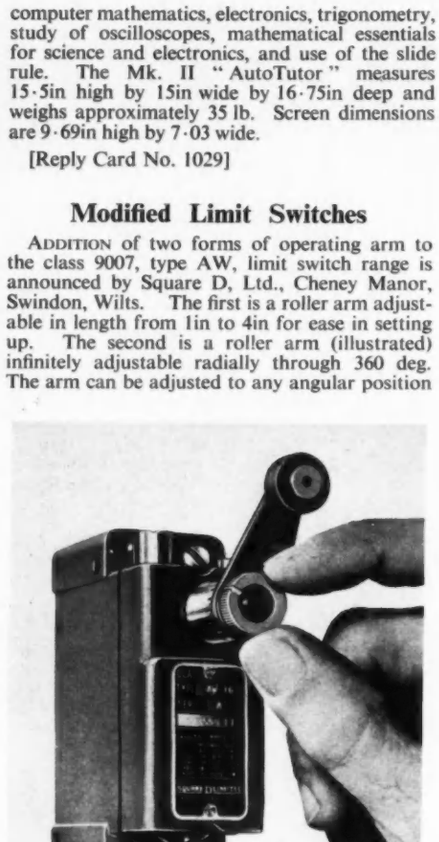
The Mk. II " AutoTutor " has simplified the Mk. I in various respects, such as the omission of moving picture sequences, but later models are to have the refinement of an automatic system for rendering all buttons except the " R " button inoperative after an incorrect answer button has been pressed. This will be achieved by photocell detection of " wrong answer " frames, which will be identified by an opaque band. Two transistors will be added to the circuit for relay operation. There are no valves in the unit, d.c. being taken from semiconductor rectifiers.

Film courses already available cover algebra, computer mathematics, electronics, trigonometry, study of oscilloscopes, mathematical essentials for science and electronics, and use of the slide rule. The Mk. II " AutoTutor " measures 15·5in high by 15in wide by 16·75in deep and weighs approximately 35 lb. Screen dimensions are 9·69in high by 7·03 wide.

[Reply Card No. 1029]

Modified Limit Switches

ADDITION of two forms of operating arm to the class 9007, type AW, limit switch range is announced by Square D, Ltd., Cheney Manor, Swindon, Wilts. The first is a roller arm adjustable in length from 1in to 4in for ease in setting up. The second is a roller arm (illustrated) infinitely adjustable radially through 360 deg. The arm can be adjusted to any angular position



Limit switch with radial adjustment arm and setting device

by rotating the knurled adjusting micrometer dial. A scale on the spindle is marked in 20 deg. graduations. One complete turn of the micrometer dial will move the arm through from one graduation mark to the next. A reference mark is located on the moving portion of the arm and the micrometer dial is provided with a position indicator so that accurate presetting and subsequent adjustment of the arm to any angular position are easily accomplished. Arms are available with a ¼in diameter by ¾in wide roller and in various lengths from ⅜in to 3in. Rollers on both the length-adjustable and rotationally-adjustable arms can be changed from outside to inside positions without the use of additional parts.

[Reply Card No. 1031]

Meters for High Pressure Gas Supply

Two new gas meters designed specifically for industrial installations using gas at pressures up to 100 lb per square inch are now being made by Parkinson Cowan Gas Meters, Stretford, Manchester. The capacity per revolution of one of these meters is 0·5 cubic feet ; and of the other 1·25 cubic feet ; the capacity of the meters at 0·5in w.g. pressure loss being 1000 cubic feet and 1500 cubic feet respectively on air, and at 2·0in w.g. pressure loss, 2000 cubic feet and 3000 cubic feet respectively.

The outer cases of the meters, one of which we illustrate, are of cast aluminium silicon and have only one main gasket joint. The index on each meter registers up to 10,000,000 cubic feet and can be positioned to allow the inlet to be on the right or left-hand side. A 10 cubic feet test dial is fitted. The measuring unit consists of four chambers enclosed within two pairs of diaphragm pans, the pans being specially shaped to ensure consistently accurate registration.

Industrial gas meter for supply pressures up to 100 lb. per sq. in.

Valve covers and seatings in the measuring units are made of a wear-resistant material and are self-lubricating.

A simple method is provided for fitting various standard volume and base pressure gauges to a meter index without an adaptor platform, the back plate of the index being slotted to take the gauge drive arm. The slot has a swivel cover to protect the index mechanism when the gauge is removed.

[Reply Card No. 1030]

Logarithmic Electronic Recorder

ALTERNATIVE logarithmic or linear response is provided in an electronic strip chart recorder announced by Honeywell Controls, Ltd., Greenford, Middlesex. The recorder has two slidewires fitted in the standard position ; the pen carriage has two sets of slidewire contacts. One slidewire is included in the measuring circuit and, to obey a logarithmic law, it is wound in twelve linear sections, each section having wire of different gauge or material. The law accuracy of the logarithmic slidewire is stated to be better than 0·4 per cent.

The second slidewire is of linear construction and is connected to a d.c. power pack from which a negative bias voltage is applied to the final voltage stage of the amplifier via the second set of slidewire contacts. Thus the magnitude of this bias voltage is relative to the pen carriage position and so provides automatic amplifier gain control to maintain stable operation over the full scale travel.

A two-position switch is incorporated in the measuring circuit to provide logarithmic or linear working. Calibration accuracy is given as better than 1 per cent, but to maintain a repeatable accuracy of 0·25 per cent over the full scale, the minimum span is restricted to 5mV.

[Reply Card No. 1033]

Association of Mining Electrical and Mechanical Engineers

NEARLY 500 members and guests attended the annual convention of the Association of Mining Electrical and Mechanical Engineers at Harrogate last week. In his presidential address at the commencement of the convention Mr. James Anderson dealt with some aspects of management first in connection with the association and then in the wider field of industry. He said that the best indication of the general efficiency of a company or an operational unit was in the profitability of its activities. Profit-making was not merely the result of greed for money; it was the only measure of overall efficiency. The fact that overall efficiency was measured in financial terms rather than in technical terms was simply because money was the one yardstick by which the comparative worth of similar goods and services could be determined.

If an organisation was to run efficiently, top management must realise that it was leading the organisation, and as such certain things were expected of management—it had to inspire and show confidence in the organisation and its future. Every organisation required a final fount of authority to which in the last resort anyone within the organisation could appeal for decisions and adjudication and it was the prime duty of top management to accept such responsibility.

Mr. Anderson considered that in these days there was too much talk about trying to run everything by rules, and this could also be said of management. A good organisation could help to make the most of the people working with it, but it could not do more than that, or add to people qualities which were not there.

Generally speaking, top management should concern itself with the future of the company rather than with the present, hence the task of top management was to direct rather than to manage; its task was the formation of policy and overall control. It was the task of a subordinate management to run the day-to-day affairs of the company within the framework of the general policy laid down by top management. It was a truism that planned progress of any business required co-operation from all engaged in the business.

POWER AT THE COAL-FACE

A paper by Mr. W. V. Sheppard on "Higher Productivity from the Better Use of Horsepower at the Coal-Face" considered the development, application and the past and present effects of substituting mechanical power for manual working at the coal-face. He dealt in some detail with the application of mechanical power to equipment for cutting, loading and transporting coal, roof support, drilling and stowing.

In connection with maintenance of plant Mr. Sheppard said that in recent years the industry had been struggling to cope with a problem that had steadily increased in complexity, namely the maintenance of a rapidly growing quantity of mechanical and electrical equipment, much of which was used below ground. The reward of substituting horsepower for muscle power was greatly increased productivity per man, but the penalty exacted by a breakdown might be the total loss of output until the fault was rectified by repair or replacement. In the past there was a tendency to regard breakdowns as inevitable and equipment was commonly allowed to run until a breakdown occurred. With modern systems of mining that policy must be rejected by everyone; to-day the maintenance of equipment was unquestionably one of the major factors—if not the major factor—in the drive for higher productivity.

In an efficiently organised and comprehensive maintenance scheme the emphasis must be on prevention rather than cure. The equipment should be designed so as to be immune from breakdown under normal working conditions for a reasonably long period, provided that it was properly serviced with grease, oil, water, &c. There was much to be said for designs evolved on the basis of sub-assembly exchange, a system developed to a high degree in the automobile industry. Although the time would come when the whole machine required to be withdrawn for overhaul, this might be considerably deferred by the periodic replacement at the coal-face of those sub-assemblies which contained the items liable to give trouble. On the other hand, there was even more to be said for designing the complete machine so that it would perform the declared duty for a minimum number of hours related to the system of mining and the rate of utilisation of the machine. This practice avoided the problems inseparable from unit replacement under adverse environmental and engineering conditions at the coal-face. Nevertheless, the equipment used at the coal-face was so varied and complicated that a compromise of both systems must be applied to some extent. Mr. Sheppard considered that action along these lines, in conjunction with the appropriate reconditioning services from supporting workshops, would probably go a long way towards solving the problem of maintaining in the most economical manner the rapidly increasing amount of machinery and equipment employed at the coal-face. There was no doubt that from the viewpoint of exchange, replacement and the supporting reconditioning services, rationalisation and standardisation of equipment could reduce costs appreciably. A too rigid measure of standardisation might impede progress, but an inadequate measure of standardisation of coal-mining equipment led to increased costs of production.

In his paper "More Horsepower for Higher Productivity at the Coal-Face," Mr. J. N. L. Woodley showed how additional horsepower could be made available, its operation and maintenance. He said that the next ten years would see a technical revolution in the means of winning coal at those new and reconstructed mines from which 80 per cent of coal output will flow. This revolution would be centred on the coal-face and it was essential that mining electrical and mechanical engineers should focus more and more of their attention on this zone so that design might be channelled on the most practicable lines and so that prototypes should be operated and maintained so as to give the greatest chance of success. The object of the paper was to consider how efficient and ample horsepower could be made available at the coal-face and to review the means which engineering science had made available to replace and supplement human effort with mechanical effort and to temper mechanical effort so that it followed more easily and absolutely the will of its operator.

The W. M. Thornton Lecture, presented by Mr. A. R. Cooper, was entitled the "Generation and Bulk Transmission of Electricity by the Central Electricity Generating Board." In this paper Mr. Cooper described graphically the layout, organisation and system of operation followed by the C.E.G.B. and its relationship with the coal industry. He said that in 1955 it was thought that the increasing demand for electricity would fast outstrip the ability of the National Coal Board to supply the industry's basic fuel requirements. Coal was in fact having to be imported during that year. It was realised that nuclear energy, the new source of power, could not be made available in time and in sufficient quantity to meet this deficit and it was decided by the Government that what was regarded as a short-term gap should be met by the import of fuel oil. Arrangements were therfore made for fourteen stations to be changed over to oil burning and contracts were entered into for the import of oil to the extent of 8,000,000 tons per annum of coal equivalent.

The coal supply position had radically changed since that date and the existence of a coal surplus in this country had naturally led to a desire on the part of the coal producers for some reduction in the amount of oil used for electricity generation. The number of oil-burning stations had in fact been reduced from fourteen to twelve.

With the impact of nuclear generation on a large scale, as from the end of 1961, the Generating Board would be manoeuvring in a three-fuel economy—coal, oil and nuclear—in which cost might not be the only consideration. In giving the probable contribution from coal, oil and nuclear stations for the three years up to and including 1965–66 Mr. Cooper said that during this period the consumption of coal for conventional power stations will have risen from its present level of 43,000,000 tons per annum to some 55,000,000 tons; the contribution of nuclear stations should be of the order of 7,000,000 tons of coal equivalent, the balance being made up by imported oil. New generating plant to be commissioned during the five years 1960–65 inclusive would amount to 12,290MW.—of this total 2405MW would be nuclear and 390MW oil-fired. The two major advances in coal-fired generating practice would be the supercritical sets at Drakelow "C," operating at 3500 lb per square inch and 1100 deg. Fah. with 1050 deg. Fah. reheat, and the first 500MW single shaft machines at West Burton.

Automatic Thermocouples

SERIOUS difficulties attend the application of thermocouples to temperature measurement in vacuum plant for melting and casting uranium and other reactive metals, including titanium and zirconium. For example, it is necessary to attach and detach the thermocouple each time the furnace is unloaded and reloaded. In addition, flexible leads must be provided to allow for any movement of the specimen. Thirdly, with ordinary methods of attachment the thermocouple is always in contact with the object although temperature readings may be required only intermittently. Finally, poor thermal contact may cause substantial delays in readings.

At Risley instrument engineers of the U.K. Atomic Energy Authority have devised and patented a thermocouple system which solves these problems by making the thermocouple retractable. It is done by mounting the thermocouple in a flexible metal sealing bellows which collapses when a vacuum is applied within the furnace and thrusts the thermocouple junction into a hole in the crucible or casting pot. A tubular guide maintains alignment and provides protection as the thermocouple cable and junction are withdrawn into it when the vacuum is released. Pressure of the thermocouple junction on the object in the furnace is controlled by an adjustable spring operating against the action of the bellows. The operation is automatic, no manipulation of the thermocouple being needed, while heat contact is good and thermal movements of the object are taken up by the thermocouple cable.

The U.K. Atomic Energy Authority has so far grated a licence for the manufacture of this device to a number of companies in the U.K. Further information is available from the Patents Licensing Officer, U.K. Atomic Energy Authority, 11, Charles II Street, London, S.W.1.

[Reply Card No. 1027]

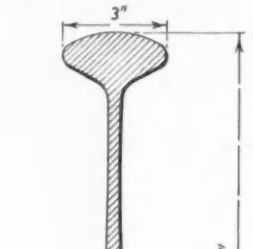
Ultrasonics Executive Committee

AN Ultrasonics Executive Committee has been set up by the Scientific Instrument Manufacturers' Association of Great Britain, 20, Queen Anne Street, London, W.1, after joint consultation with a number of interested manufacturers to study the problems arising and to see what may be done to bring order into this field. The need for the Committee arose after a discussion between Dawe Instruments, Ltd., and Mullard Equipment, Ltd., and is under the chairmanship of Mr. W. Owen-Roberts of Mullard Equipment, Ltd. Members of the Committee will include representatives of Dawe Instruments, Ltd., W. Bryan Savage, Ltd., Kelvin and Hughes, Ltd., Standard Telephones and Cables, Ltd., and Smiths Industrial Division of S. Smith and Sons (England), Ltd. The Executive Committee will organise a number of working groups to study the various aspects of the subject and representatives from other firms concerned with the ultrasonic field have been invited to participate in the work. The first work will be a study of the terminology used in ultrasonic work. The next will be a detailed study of the measurement of acoustic power in liquids, the assessment of ultrasonic cleaning efficiency, the problems associated with the use of ultrasonics in flaw detection and measurement, those arising from the medical application of ultrasonics and those due to the increased industrial use of ultrasonics. The Committee intends to make recommendations for action which will be passed to the appropriate national and international bodies for consideration.

SHORTER REPORTS *(Continued)*

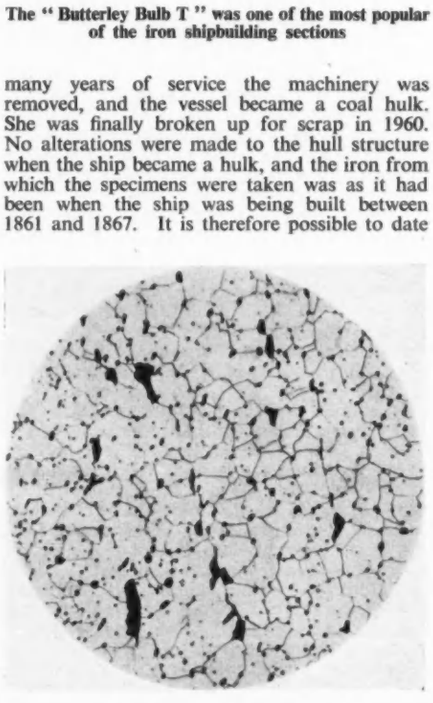
Rolled Sections from the Iron Ship Era

Two pieces of rolled wrought iron section which have been presented to the Birmingham Museum of Science and Industry and the Science Museum, London, respectively, form a direct link with the days of iron shipbuilding. The iron was taken from H.M.S. " Agincourt," a 10,690-ton armour-plated screw cruiser, the keel of which was laid down on October 30, 1861. " Agincourt " was completed in June, 1867, and commissioned the next year. After



The " Butterley Bulb T " was one of the most popular of the iron shipbuilding sections

many years of service the machinery was removed, and the vessel became a coal hulk. She was finally broken up for scrap in 1960. No alterations were made to the hull structure when the ship became a hulk, and the iron from which the specimens were taken was as it had been when the ship was being built between 1861 and 1867. It is therefore possible to date



This micro-section shows clearly the ferritic structure and slag inclusions of a classic wrought iron

these particular pieces of iron for certain to within seven years, and since they were taken from above keel level it is reasonable to assume that they were actually rolled between about 1862 and 1864.

When iron ships were first built the structural sections available at the time—angles and tees—were adequate for the purpose. As the sizes of ships increased heavier sections were needed, and it was not easy, for technical reasons, to roll them from wrought iron. In 1858 John (later Sir John) G. N. Alleyne, of the Butterley Ironworks, Derbyshire, obtained a patent (No. 2107) for improvements in the manufacture of wrought iron beams and girders. He took out further patents in 1861 (No. 825) and 1862 (No. 1228) covering the machinery for making beams. Alleyne's original beams were made of two or more pieces, joined by longitudinal riveting or fire welding. Various cross sections were included in the patents, but the one which became most popular was a tee section with a bulb end at the foot. This became known as the " Butterley Bulb," and large quantities were rolled by the Butterley Company. Other manufacturers also produced bulb tees, and later they were rolled from steel, but the name Butterley Bulb was generally bestowed on all sections of this type, regardless of material or manufacturer.

Pieces of wrought iron a century old, of which the history is definitely known, are not common, and for this reason the Butterley Company, Ltd., Ripley, Derbyshire (which still numbers wrought iron among its many different products), undertook to prepare the specimens for the museums and to carry out chemical and physical tests on the iron. Wrought iron is the purest form of iron commercially available, and should possess, *inter alia*, very good properties of elongation and reduction of area. It should also, of course, carry the minimum of impurities. On all these counts the specimens were found to be excellent, as the following figures show :

Analysis :	
Carbon, per cent	0·04
Silicon, per cent	0·28
Manganese, per cent	0·058
Sulphur, per cent	0·017
Phosphorus, per cent	0·272
Physical properties :	
Tensile, maximum stress ...	22·7 tons per square inch
Elongation	32 per cent on 4in
Reduction of area, per cent ...	35
Brinell hardness	137

A microscopic examination of the material shows, as would be expected, a completely ferritic structure with considerable slag inclusions —in short, a typical classic wrought iron.

Hydraulics Research 1960

THE annual report of the D.S.I.R.'s Hydraulics Research Station for 1960 has been published by H.M. Stationery Office. Some typical examples of the work done by the Station during the year are as follows :

Hong Kong Harbour.—Land reclamation in Hong Kong harbour has created a need for study of its effect on tidal streams and, consequently, on navigation. One of the problems investigated on a model was the likely influence of a proposed mile-long bridge across the harbour. The design provided for unusually large piers, to withstand the impact of a ship adrift in a typhoon. Although these piers would cause some increase in the velocity of currents, it was considered that their effect on navigation would otherwise not be significant. Other investigations concerned the effect of a proposed tunnel, the roof of which was designed to project above the sea bed. In this case, it was found that only the lower layers of water would be primarily affected by the obstruction. Two reclamation schemes were also studied, and in neither case was any significant change in the tidal flow observed.

Model Tests for Blackfriars Scheme.—Tests have shown that shipping passing under the Blackfriars road and railway bridges will not be subjected to any danger when the proposed underpass between Victoria Embankment and Queen Victoria Street is built. The work, which will be carried out by the Corporation of the City of London, will involve altering the alignment of part of the Thames river wall, and it was thought that the flood stream might be deflected across the channel, causing difficult conditions under the bridges for the large colliers which make their way downstream against the flood tide. The scheme is expected to cost £3,0000,000, and work should start next year. In the tests, a scale model of the Thames between Southwark Bridge and a point more than 400 yards upstream of the Blackfriars bridges was used. The river currents were simulated, and a radio-controlled model was used to represent a collier. When a structure representing the new wall was introduced, it was found that changes in the pattern of flow did not extend to the navigation channel.

Terminal Groyne Problem.—A model was constructed to study the accretion and erosion of beaches where the presence of groynes disturbs the normal process of littoral drift and, in particular, the erosion at the down-drift end of the groyne system (movement of material along the coast under the action of waves). The experiment was designed to measure the littoral drift along beaches with and without groynes, and it confirmed that the rate of growth of the scour hole, at the down-drift end of the system, was equal to the difference between the rates of littoral drift on beaches with and without groynes.

Karnafuli River, East Pakistan.—Experimental work on the first stage of this investigation of means of improving the navigation channels to the Port of Chittagong on the River Karnafuli has been completed, and recommendations have been made to the Chittagong Port Trust for training the upper river. The most urgent need is for an embankment and two training walls, with a total length of 9600ft, to close the by-channel at the junction of the Karnafuli and Halda rivers. Stage Two of the investigation, which deals with the improvement of the depths at the river entrance bars and the downstream channels, is expected to be completed this year.

The Effects of Friction and Reflection on Tides in Estuaries.—The mathematical theory of wave motion in uniform frictionless channels has been applied to the propagation of tides in estuaries, and calculations have been made on two estuaries of different types—the Thames Estuary and the Bristol Channel. The former demonstrated the effects of reflection and the latter effects of friction.

International Congress on Combustion Engines

A REPORT presented by the British National Committee at a general meeting held on June 7 stated that work had begun on the organising of the United Kingdom's participation in the Sixth International Congress which will take place in Copenhagen between June 18 and 23, 1962. The conference theme, which is limited to the higher range of horsepowers, will be " Recent Developments with Diesel Engines and Gas Turbines above 3000 h.p. per engine and with Gas Engines above 1500 h.p. per engine." The subjects likely to be covered are : large slow-running, medium and fast running and dual fuel engines ; developments of supercharging ; engine components ; heat transfer and heat release problems ; free piston gas generator turbines ; gas turbines ; and heavy fuel in diesel engines and gas turbines. The Congress includes six double technical sessions, and three works visits sponsored by Burmeister and Wain, Elsinore Shipbuilding and Engineering Company and Kockums McKeniska Verkstaats A/B. The report mentions that at its March meeting in Gothenburg the permanent committee invited the United Kingdom to be the host country for the Seventh Congress to be held in 1965. This has been accepted by the British National Committee and London has been selected as the possible venue. Also noted was the completion of the work undertaken by C.I.M.A.C. in preparing a set of international recommendations for acceptance tests for diesel engines and that consideration was now being given to the question of acceptance tests of pressure-charged engines.

Console and printer of high-speed computer system, showing some of the twelve magnetic tape units forming simultaneous input and output channels

Data Processing Centre

FACILITIES for commercial and scientific organisations to write their own computer programmes and operate machines themselves are provided at the Data Centre of IBM United Kingdom, Ltd., which was opened on June 7 at 58, Newman Street, London, W.1, by Sir Roger Makins, Chairman of the United Kingdom Atomic Energy Authority. Speaking of the uses to which computers were put by the Authority, Sir Roger Makins said these came under the main headings of weapon development, research, and problems of reactor development. They had enabled the most efficient reactor operating conditions to be worked out, and at Calder Hall and Chapelcross, for example, an increase in electrica output of more than 25 per cent over the design figure would shortly be achieved. In carrying out experiments with fuels at these stations, computers enabled the effect of inserting test elements to be calculated in advance, so that the requirements of electrical production and experimental work could be reconciled. Increased output of electricity due to precise methods of calculation would be worth £500,000 a year to the Authority.

Mr. T. C. Hudson, Managing Director, IBM United Kingdom, Ltd., spoke of the future possibilities of teleprocessing systems linking warehouses and factories with a centre such as this. Direct character sensing from printed matter was a further step in which they were interested as a means of deriving maximum benefit from computing systems. A series of courses had been prepared for the instruction of top industrial management in what computers could do.

After the opening, the installation of the IBM 1401 and 7090 data processing systems was inspected. The two work together, the 1401 being used to convert information on punched cards into magnetic tape form for processing by the 7090. Similarly, the 1401 will convert output tapes from the 7090 into punched cards or printed documents. We illustrate the control console and printer of the 7090 equipment, together with some of the twelve magnetic tape units. These form two independent data channels, both of which can be used for input or output while the computer is engaged simultaneously on arithmetical and logical operations. This arrangement enables the best advantage to be taken of the high-speed characteristics of the 7090, since information taken in on one channel can be processed and then printed out on the second while intake and computing continue. The operation demonstrated at the opening of the centre was the assembly on magnetic tape, in ascending sequence, of data received in random order and equivalent to that contained in 39,000 sixty-column cards. This took 8½ minutes, compared with sixty hours (plus 10 or 15 per cent handling time) on a typical mechanical sorter working at 650 single-column cards a minute.

[Reply Card No. 1026]

Zinc-Lead Sinter Crushers

WE illustrate below one of two similar single-roll crushers specially developed by The General Electric Company, Ltd., for handling hot zinc-lead sinter. These 60in by 24in " Pennsylvania " crushers, were ordered by Lurgi of Frankfurt for installation in two updraught sinter plants at Broken Hill, Rhodesia. When operating, each crusher will be fed with hot sinter from a pallet 59in by 39in by 12in and, according to its setting, will give a product size of either 3in or 4in at a rate of 48 tons per hour.

Each crusher has a welded frame housing an alloy steel toothed roll and an adjustable steel breaker-plate. The crushing roll is driven at 20 r.p.m. by a 25 h.p. squirrel-cage motor through a " Twiflex " coupling and a David Brown worm gearbox. Grease labyrinth seals are used with the sleeve bearings of the main shaft and provision is made for water-cooling of the shaft in the vicinity of these bearings. To protect the machine against the effects of overloading, or if it receives an uncrushable object, it is fitted with spring-loaded toggles which allow the breaker-plate to open and reset automatically.

Although the crushers will be set to give a product size of either 3in or 4in, the breaker-plate adjustment enables the product size to be varied within wide limits.

[Reply Card No. 1019]

Single-roll zinc-lead sinter crusher

Alloy-Diffused Transistors

FURTHER mesa transistors produced by the germanium alloy-diffused process are announced by Texas Instruments, Ltd., Manton Lane, Bedford. They are intended for operation in high frequency amplifiers and fast switching circuits. The 2G401 device is a high-gain i.f. amplifier for 465 kc/s and 10 Mc/s ; 2G402 is a v.h.f. amplifier at 100 Mc/s ; and 2G403 is for logic and arithmetic circuits operating at clock rates of 10 Mc/s. For reliability under extreme environmental conditions, these transistors are hermetically enclosed in an all-welded package. Wide lead spacing permits automatic insertion on printed boards in production equipment. The alloy-diffused mesa technique confers the qualities of low leakage currents, improved high-frequency operation, good bottoming characteristics and increased power dissipation. Combining these features in a single device enables circuit design to be simplified.

[Reply Card No. 1034]

Indian Engineering News

BY OUR INDIAN CORRESPONDENT

Utilisation of Fines from Mechanised Ore Mining

The mechanisation of Rajhara iron ore mines, some 55 miles from the Bhilai steel plant at an estimated cost of Rs.6 crores, is under way. These mines are computed to contain 114 million tons of ore extending over a length of 4 miles, and will supply 7000 tons of ore daily to the Bhilai plant to enable it to produce 1,000,000 tons of steel a year. In addition to the installation of 27,000-ton heavy mechanical equipment received from the Soviet Union, construction of large crushing and screening buildings has been completed. Claimed to be one of the world's best ore bodies, with an iron content of 65 to 70 per cent, the Rajhara mines are linked to the steel plant by rail constructed by the South Eastern Railway at a cost of Rs.4 crores.

With the rapid increase in the production of iron ore to meet the requirements of the expanding domestic steel industry, and the waxing ore export trade especially with Japan, the utilisation of large quantities of fines which are incidental to mechanised mining has become an issue of first-rate importance. The Government of India has therefore set up an eight-member committee to study the problem of utilisation of such iron ore fines. This body will study and make recommendations on the aspects of utilisation of iron ore fines in all its bearings including the extent of fines production and the cost at which these can be procured. The various technical processes for agglomeration to render fines fit for steel plants, for export, together with their economics, will also be pursued by the committee. It will finally study the extent to which fines can, and should, be made use of in Indian steel plants and the measures for achieving this end.

INDUSTRIAL NEWS

Industrial Investment in Western Australia

The Government of Western Australia has published a report prepared by a team of British industrialists which visited Western Australia in October last year at the invitation of the Minister for Industrial Development, to investigate at first hand opportunities to establish new industrial capacity there and generally to stimulate wider interest in the development of secondary industries. The team was led by Mr. J. O. Knowles, director of Metal Industries, Ltd., while most of the other members had engineering interests, electrical, mechanical and chemical engineering being all represented.

The report includes a survey of the general industrial development in Western Australia, and goes on to discuss further industrial possibilities. The value of mined minerals, other than gold and coal, was about £A6,000,000 in 1959, and it is suggested that efforts should be made to develop the further processing of the natural product before it is exported. Capital, "know-how," efficient manufacturing plant and market research are all required to achieve this aim. It would seem, the report says, that there is some scope for the local processing of gold, which is at present exported in bulk for additional refining and processing. On its visits to heavy engineering works in the Perth district, the team noted that the addition of other products requiring machines and facilities for production would seem to be possible by co-operation with British manufacturers. While in the present stage of Western Australian development the market for many engineering products would not justify setting up a separate new works, the report suggests that the method of adding to the products of existing works could prove economic. The conversion of the present narrow gauge railway to standard gauge should bring an increase in demand for rolling stock, but the team thinks that there are very definite limits to the possible growth of rolling stock manufacture. On the other hand, the report says, road vehicles of all types are constantly increasing in number, and are likely to go on doing so as the population grows both in size and in wealth, and there may be an opportunity here for more assembly work to be done in the State. A large demand for nitrogenous fertilisers will arise when agriculture starts to become intensive, and when it does, the report says, there is a very strong case for such a manufacture, based on the use of cheap opencast coal. Textile production should find room for growth, the team suggests, particularly in view of rising imports, which totalled £A11,000,000 in 1959. There would also appear to be scope for the manufacture of the more popular types of electrical cable.

Efficiency in the Coal Industry

In his closing speech at the Edinburgh Conference of the National Association of Colliery Managers last week, Mr. Alfred Robens, chairman of the National Coal Board, said that the greatest threat to the future of the coal industry was the consumers' fear of rising prices. It was absolutely essential to ensure price stability, and this meant, he added, that all increased costs must be paid for by constantly rising productivity. This could be done, Mr. Robens continued, provided management and men co-operated in improving productive efficiency, but failure to do so would inevitably mean a further contraction of the industry in the face of intense competition from oil.

Mechanisation was the key to increased efficiency, Mr. Robens said, but it was not simply a matter of buying and installing machines. They must be used to the full to get the maximum return on the investment they represented. This could only be achieved by working the machines over two or three shifts whenever possible instead of one, by reducing the machine time lost in stoppages, and by seeing that every man in the pit behind the coal-face and on the surface was used 100 per cent effectively.

Output this year would be about 190 million tons, and as demand for coal was likely to approach 200 million tons, industry would again be able to reduce its stocks. This year another 6,000,000 tons have been lifted and sold, making a total reduction of 13,000,000 tons from the peak figure of 36,000,000 tons at the end of 1959. The end of the surplus stocks was in sight, Mr. Robens said, for industry would need to carry a planned level of stocks of some 10,000,000 tons.

So far this year, output per manshift has risen by nearly 2 per cent.

Employment

The latest figures issued by the Ministry of Labour show that during April the number of people in civil employment in Great Britain is estimated to have increased by 54,000 to 23,764,000. This is 310,000 higher than the corresponding figure for April, 1960. Two-thirds of this increase was accounted by a rise in the number of women in employment. In manufacturing industries as a whole, the Ministry says, employment increased by 22,000, more than half of this increase occurring in the metals, engineering and vehicles group of industries.

The number of operatives working short-time in the week ended April 29 in establishments with eleven or more employees in the manufacturing industries was estimated at 63,000, the Ministry states, which was 4000 more than at the end of March and 38,000 more than at the end of April, 1960.

Construction

According to provisional figures collected by the Ministry of Works, contractors in Great Britain carried out constructional work to the value of £561 million in the first quarter of 1961. This was £2,000,000 higher than the output in the fourth quarter of last year and £61,000,000 more than in the first quarter of 1960.

The value of new housing work is reported to have risen only slightly compared with the previous quarter but was £15,000,000 higher than a year ago. Nearly all of the increase, the Ministry says, was in work for private developers. The value of industrial building continued to rise and was £21,000,000 higher than in the first quarter of 1960, while the value of miscellaneous building dropped by £3,000,000 compared with the previous quarter but was £7,000,000 higher than a year earlier. The value of work done for public authorities, other than housing, was £9,000,000 more than in the first quarter of 1960.

The value of new orders obtained by contractors in the first quarter of 1961 amounted to £521 million and was the highest figure reached since this series of figures was first collected by the Ministry in 1957. It was £48,0000,000 or 10 per cent more than in the first and the last quarters of 1960, and about 15 per cent higher than in the middle quarters. The value of work coming forward in the public sector, in particular work other than housing, showed a considerable increase, the Ministry says, rising from £131 million in the first quarter of last year to £157 million this year. Most of the contracts let during the first quarter will be in progress during the fourth quarter of the year, and, the Ministry points out, will therefore include an allowance for the wage increase which takes effect in October and for other price increases.

The number of operatives employed by contractors in the construction industries in April was 1,107,000, the highest figure recorded for employment in April since the end of the war. Employment throughout the first quarter has averaged 40,000 more than in 1960, stimulated partly, the Ministry suggests, by the exceptionally good weather.

Compensation Plan

The Steel, Peech and Tozer branch of The United Steel Companies, Ltd., has announced that over the next five years it will be replacing its twenty-one open hearth furnaces by six 110-ton capacity electric arc furnaces. This development, it is claimed, will give the works the largest electric steel-making plant in the world, capable of producing an annual ingot output of 1,350,0000 tons of steel, compared with the present level of 1,000,000 ingot tons. As a result of this change-over, the company's labour force will be reduced by over 1000 men. Some of the men affected are to be retired whilst some will be made redundant, but it is hoped, The United Steel Companies states, that no permanent members of the labour force will need to be made redundant and that redundancy will be confined to temporary employees.

It is expected that the company will be able to provide continuing employment for established regular employees, but this will mean offering some of them jobs in departments other than the new melting shop, as they become available. In the main, the company states, these jobs will be less highly paid and in the new melting shop itself there will be fewer highly paid jobs than at present. The earnings of some hundreds of workers, therefore, will be reduced. The amounts will vary from man to man, it is stated, but the bulk of employees affected are likely to lose between £3 and £6 per week.

Because it is felt that the company owes a responsibility to its workpeople, many of those who will have to change their jobs having given long and loyal service, the company proposes to pay some compensation for loss of status and earnings. The compensation will take the form of an *ex gratia* payment which will take into account loss of earnings, years of service, and age. The maximum payment to any one man will be £300.

PERSONAL AND BUSINESS

Appointments

MR. J. R. HOLLIDAY has been appointed publicity manager of British Ropes, Ltd.

MR. E. B. AUGOOD, A.M.I.Mech.E., A.M.I.E.E., has been appointed works manager to Ultra Electronics, Ltd.

COCHRANE AND SONS, Ltd., has appointed Mr. D. M. Wait as general manager at the Ouse Shipbuilding Yard, Selby.

SIMON EQUIPMENT, Ltd., announces that Mr. A. A. Haining has joined the company as sales manager and Mr. H. Powell as production manager.

MR. E. MASON has been appointed general manager of the factory of Rank Precision Industries, Ltd., ciné and photographic division, Mitcheldean, Gloucestershire.

MR. H. D. SYKES has been appointed resident representative in Sweden of Baker Perkins (Exports), Ltd. He will operate from an office at Radarvagen 9, Viggbyholm, Stockholm.

MR. R. G. HUXTABLE is to be the new secretary of The Gas Council: on August 1, he succeeds Mr. Wilfrid Bailey, who becomes deputy chairman of the Southern Gas Board.

STUBS WELDING, Ltd., has appointed Mr. W. J. Austin-Clarke to represent the company in Staffordshire, Mr. J. Mayers in Warwickshire, and Mr. O. Summers in Worcestershire.

SIR PETER ROBERTS, BT., THE RT. HON. LORD RIVERDALE, SIR ROBERT ADEANE, MR. FREDERICK H. BROOKS AND MR. KENNETH E. WALKER have been appointed to the board of Hadfields, Ltd.

HILGER AND WATTS, Ltd., announces that Mr. A. H. Campbell, M.I.E.E., director and general manager, has been appointed joint managing director with Mr. G. A. Whipple, M.I.E.E., F.Inst.P.

MR. G. H. GREENHALGH of the United Kingdom Atomic Energy Authority has been appointed Nuclear Energy Attaché to the United Kingdom Delegation to the European Communities, to succeed Mr. D. H. Hill.

SIR EDWARD PLAYFAIR has been appointed chairman of International Computers and Tabulators, Ltd., with effect from August 1, when he will be released from the post of Permanent Secretary to the Ministry of Defence.

THE SOUTH WESTERN ELECTRICITY BOARD announces the appointment of Mr. Francis Richardson to be its Bristol district manager. He succeeds Mr. A. G. Milne, who was recently appointed chief engineer of the London Electricity Board.

GRANT, LYON AND CO., Ltd., states that Mr. G. A. Jones, formerly the company's South Wales regional manager, has been appointed technical representative for the whole of England and Wales, with the exception of Durham and Northumberland.

DOWTY GROUP, Ltd., has announced three appointments to the board of its subsidiary Malta Rubber, Ltd. They are: Mr. F. Bastow, chairman, Mr. E. Davies, director and general manager, and Professor Felix Cremona, director. Mr. A. V. Galley has been appointed secretary.

MR. L. A. THOMAS, F.Inst.P., A.M.I.E.E., has been appointed chief physicist at the Hirst Research Centre of The General Electric Company, Ltd. He will be a member of the staff of the Central Research Laboratories with special interest in the programmes of long-term and fundamental research.

AMBUCO, Ltd., states that Mr. E. W. F. Clements, M.I.C.E., M.I.Mech.E., has been appointed a director of the company. Mr. Clements is chief mechanical and electrical engineer of The Consolidated Gold Fields of South Africa, Ltd. Mr. J. L. Webb has taken up the position of contracts manager.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. F. D. Bolt, M.I.E.E., as head of transmitter equipment section, planning and installation department, in succession to Mr. D. B. Weigall, M.I.E.E., who has been transferred to the staff of the senior superintendent engineer, external broadcasting for special duties.

THE MINISTRY OF AVIATION announces that Mr. Joseph John Taylor, at present general manager and secretary of the Workers' Travel Association, has been appointed a member of the Air Transport Licensing Board. He will become deputy chairman of the Board from August 1, 1961, by which time he will have retired from his present post. Mr. Alfred Harold Wilson, who has been filling the office on a temporary basis, has agreed to continue to serve as deputy Chairman until July 31, 1961, and will thereafter remain a member of the Board.

Business Announcements

MR. R. F. HOCKIN, A.M.I.Mech.E., has resigned from the board of directors of Burtonwood Engineering Company, Ltd., in order to devote more time to his other interests.

F. PERKINS, Ltd., Peterborough, states that a new motor vehicle workshop named after Mr. Frank Perkins, founder and chairman of the company, has been officially opened at Peterborough Technical College.

CENTRAX, Ltd., Newton Abbot, announces that it has been granted a licence by the Rockwell Standard Corporation, U.S.A., for the exclusive rights to manufacture and sell in the United Kingdom, the Rockwell Standard range of planetary axles.

JOHNSON, MATTHEY AND CO., Ltd., 73-83, Hatton Garden, London, E.C.1, announces that it is now able to supply scandium, yttrium, and most of the fourteen rare earth metals in sheet form in thicknesses down to 0·001in and with a maximum width of 3in. The sheet is available either cold worked or annealed.

STEEL (DINSDALE) AND CO., Ltd., Court Chambers, Coniscliffe Road, Darlington, Co. Durham, has been appointed selling agent for the United Kingdom, the Commonwealth and continental Europe by the McCartney Manufacturing Company, Inc., Baxter Springs, Kansas, U.S.A., manufacturers of tungsten carbide cylinder liners, etc.

THE SOLARTRON ELECTRONIC GROUP, Ltd., Farnborough, Hampshire, announces that Solartron Laboratory Instruments, Ltd., has signed an agreement with Packard Bell Electronics Corporation, granting Packard Bell a licence to manufacture the Solartron CD.1014 portable double beam oscilloscope and the CD.1016, the rack mounted version of this instrument, in the United States of America.

CRANES (DEREHAM), Ltd., South Green Works, Dereham, Norfolk, and Fruehauf International, Ltd., the overseas organisation of Fruehauf Trailer Company, Detroit, Michigan, U.S.A., are to have a joint interest in a new British company. A new factory is to be built at North Walsham, Norfolk, to produce a full range of commercial semi-trailers and it is planned for production to commence early in 1962.

P.M.T. (MACHINE TOOLS), Ltd., Oozells Street, Birmingham, 1, has recently been appointed exclusive distributor for S.A.I.M.P. of Italy, manufacturers of precision lathes and milling machines. A comprehensive stock of lathes from 7in by 30in between centres up to 16in by 240in between centres, and milling machines, vertical, universal and turret type, can be seen under power at its Birmingham Showrooms.

PARKINSON COWAN, Ltd., states that as a result of a sales agreement with the American Meter Company, Inc., Philadelphia, U.S.A., it is now marketing in Great Britain the American company's volume and pressure gauges and base pressure and volume indexes. All equipment covered by the agreement is for use with the new type of high pressure meter recently introduced to this company by Parkinson Cowan and also with the Connersville-type meters distributed by W. C. Holmes and Co., Ltd.

WILLIAM DOXFORD AND SONS, Ltd., and THE SUNDERLAND SHIPBUILDING DRY DOCKS AND ENGINEERING COMPANY, Ltd., announce that the proposals for the merger of the two companies were approved at the meetings of members of Doxford held last week and by the acceptance of the share exchange offer in respect of more than 90 per cent of the issued preference shares and of the issued ordinary shares of Sunderland. It was expected that the change of name of Doxford to The Doxford and Sunderland Shipbuilding and Engineering Company, Ltd., would become effective on Wednesday June 14.

Contracts

THE CALEDON SHIPBUILDING COMPANY, Ltd., is to build a motor ship of 12,000 tons deadweight for E. G. Thomson (Shipping), Ltd., and David Rowan and Co., Ltd. are to supply the propulsion machinery consisting of a Sulzer 6RD76 diesel engine of 9000 b.h.p.

THE ENGLISH ELECTRIC COMPANY, Ltd., has been awarded the contract to provide the diesel-electric propulsion machinery for a hydrographic survey vessel for the Australian Navy. The twin-screw machinery will consist of three 16-cylinder diesel engines of 1987 b.h.p. and three 1330kW generators, supplying power to two 2500 s.h.p. propulsion motors.

WILLIAM HAMILTON AND CO., Ltd., has received an order for a self-unloading cargo vessel of 9000 tons deadweight from the Hall Corporation of Canada. The ship will measure 370ft by 58ft by 30ft and be propelled at a service speed of 11¼ knots by two Polar engines each of 1650 b.h.p. at 335 r.p.m.

FERRANTI, Ltd., has received an order from the Central Electricity Generating Board (through its Northern Project Group) for two 400MVA, three-phase, 50 c/s, double-wound transformers for installation at Blyth "B" Power Station, Northumberland, to step up the generator voltage to 300kV and to provide a direct connection to the supergrid. The transformers will be water-cooled and will be fitted with Ferranti high-speed resistor-transition on-load tap changing equipment. The consulting engineers are Merz and McLellan.

THE ENGLISH ELECTRIC COMPANY, Ltd., is to supply the first switchgear for the C.E.G.B. projected 400kV supergrid. This order, worth about £1,500,000, will cover thirteen 35,000MVA air-blast circuit breakers (eight of which will be rated at 4000A and five at 2000A) together with power-operated isolators and other equipment to form a complete duplicate-busbar switching station adjoining the West Burton, Notts, power station. It is believed to be the highest rated switchgear on order. The company is also supplying the four 500MW single-line steam turbo-alternators for West Burton power station.

A. MONK AND CO., Ltd., has been awarded a contract valued at £143,000 for the construction of a factory for Taylor Controls, Ltd., at Stevenage, Hertfordshire. There will be a single-storey, steel-framed, flat roofed building of a floor area of about 40,000 square feet, and three single storey ancillary buildings of a total floor area of about 850 square feet. Other works include the construction of roads, drains, sewers and a car park; fencing; and the construction of a small range of swarf bins, an open transformer compound and sundry minor works. The contract period is approximately twenty-nine weeks, the completion date being November 30, 1961.

PETER LIND AND CO., Ltd., has been awarded a £250,000 contract for the basement for the Museum Telephone Exchange and the foundation for the radio tower by the Ministry of Works. The basement will be about 200ft square by 25ft deep, comprising the basement floor, lower ground floor, and ground floor. To obviate noise and vibration, it will be surrounded by a reinforced concrete wall, constructed in a form of trench excavation, and the use of a stabilising solution by the Italian firm I.C.O.S. This wall forms a permanent wall of the basement. The foundation of the tower will be of cellular construction, incorporating a pre-stressed concrete slab, and will ultimately support the radio tower, which will be more than 500ft high and which will incorporate a restaurant near the top. The work up to ground level is to be completed by the end of this year. (See page 218, Feb. 10, 1961.)

VICKERS AND BOOKERS, Ltd., London, has been awarded a £7,500,000 contract for the design and supply of all plant for two beet sugar factories in the Soviet Union by Techmashimport of Moscow, who are represented in Britain by the Russian Trade Mission, permanently resident in Highgate, London. Four large sugar silos worth over £500,000 have been designed for these factories in the office of the chief civil engineer of John Laing and Son, Ltd. Two silos are to be constructed at a factory at Brukhovetskij in the Caucasus and two at Nikolaevskij on the Black Sea coast. Construction work is likely to begin on the projects towards the end of this year. Each silo will have a capacity of 20,000 metric tons of sugar and will measure 118ft in diameter and 113ft in height. Walls will be constructed in pre-stressed concrete on raft foundations and special sliding formwork will be used. The silos have been designed to metric dimensions in materials readily available in Russia. All drawings and other documents have been prepared in both Russian and English and technical discussions have taken place with Soviet engineers during the design stage.

Miscellanea

SCREW PITCH GAUGE.—A new screw pitch recognition gauge added to the range of kit gauges made by Moore and Wright (Sheffield), Ltd., Handsworth Road, Sheffield, 13, contains Whitworth and Unified thread gauges. Thirty blades at one end of the gauge give Unified threads from four to forty-two threads per inch and twenty-eight blades at the other end give Whitworth threads from four to sixty threads per inch.

CONTINENTAL AFFAIRS

by Our Continental Editor

Hagestein Weir

With the recent completion of the weir at Hagestein on the Lek which has been under construction since 1954, *an important step forward has been taken towards the canalisation of this section of the River Rhine. The scheme is designed to permit water from the Rhine to be drawn off through the River Ijssel towards the former Zuidersee where fresh water is stored for agricultural and industrial use in the central and northern parts of Holland ; at the same time, navigation on the Rhine and Ijssel will be improved. The canalisation is to be completed by* 1968 *by the building of two further weirs, at Amerongen and Driel, which will be similar in design to Hagestein. The project dovetails with the Delta Plan upon which it depends for preventing a silting up of the Port of Rotterdam which might otherwise result.*

IN their present intensified phase, the century-old Dutch efforts to preserve and improve the country centre upon three main objectives : the "Delta Plan"; polder construction on the Lisselmere (Zuiderzee); and the canalisation of the Rhine.

While the "Delta Plan"—which aims at shutting off from the sea the southern arms of the Rhine delta, leaving open only the Nieuwe Waterweg, the seaway to Rotterdam—goes back a good many years, the final impetus for its implementation was given by the disastrous floods of February, 1953. Since that time, important progress has been made with a project which on account of its enormous extent and the size of the investment involved, will not be completed before the mid-seventies. The concept of the "Delta Plan" and the initial stages of construction have been described in this journal.* Reclamation of the Zuiderzee has been in progress since the completion of the 30km long dyke which was closed on May 28, 1932. Of the total area of 3500 square kilometres, 1900 are to become polders while the rest will remain as a waterway and freshwater reservoir.

A link between these two schemes is formed by the canalisation of the River Rhine which was begun in 1954 and is due for completion in 1968. A short distance below the point where the Rhine divides into its two principal arms, the Nederrijn and the Waal, there branches off the Nederrijn the River Ijssel which runs in a north-westerly direction into the Ijsselmeer (Fig. 1). This connection with the Rhine forms an important waterway, as well as the principal source of fresh water for the agriculture of the northern part of the country and for the industrialised region of Twente.

It is one of the objectives of the Rhine Canalisation to improve the navigability and flow of the Ijssel, especially during periods when the Rhine itself carries little water. At present, 1000-ton coal barges are unable to reach Twente during six months of the year.

The proportion in which the Rhine waters are to be shared between the Nederrijn and the Waal has been fixed as 1 : 2 by the Acts of Mannheim (1868) in which the regime of the river is internationally laid down. For that reason nothing must be done which would affect the flow in the Pannerden Canal—as the section between the Nederrijn-Waal bifurcation and the Ijssel is called—to the detriment of the Waal which forms one of the world's major inland shipping routes. On the other hand there is no statutory objection to increasing the flow in the Ijssel at the expense of the downstream part of the Nederrijn. It is, however, essential to maintain facilities for navigation as well as the biological self-cleansing in this river. These requirements are met by the design of the Rhine Canalisation.

The bed in the Pannerden Canal, Nederrijn-Lek and Ijssel is to be lowered in order to prevent the impounding effect from extending into the international river and so affecting the repartition. Lowering the river bed could on the other hand lead to a flow increase during floods. It is intended to prevent this by constructing groynes in the inundation forelands.

A minimum flow of 50 cumecs through the Nederrijn has been assumed to be adequate to keep the river clean. Any further reduction would have to be compensated in some way. The possibility has therefore been left open to make good such a deficit by supplying water from the Waal through the Tiel Canal.

A factor which facilitated construction was the ample width of the inundation forelands along the river. It has been possible to site the weirs and lock installations in loop cut-offs, so that the construction work does not in any way interfere with shipping.

In order to keep down the cost of the project, there had to be as few stages as possible. On the other hand, the damage to the surrounding country from changes in the ground water level had to be limited as far as could be. It was found that three weirs were necessary. They are being sited at Hagestein, Amerongen, and Driel. Of the three, Hagestein, which forms the principal topic of this article, was officially commissioned on June 1. The locks belonging to this stage will be ready for commissioning early next month.

Choice of site of Hagestein, the most downstream of the three stages, was dictated by the desire to have the first weir above Vreeswijk where two canals join the river. In this way the important inland shipping route between Rotterdam and Amsterdam is hampered by only one pair of locks.

The uppermost weir has to be placed comparatively close to the Ijssel Kop, the bifurcation of Nederrijn and Ijssel. Otherwise, accurate control of the relative flow in the two river branches would be impossible, and the damage to the surrounding land from seepage would be great. On the other hand, if this weir were sited too far upstream, the number of stages would have to be increased, resulting in a considerable addition to the total cost, as well as increasing the number of locks which the ships would have to pass through. With the weir sited at Driel, it was found that a single intermediate stage would suffice.

This intermediate weir is scheduled to be constructed at Amerongen which is about halfway between Driel and Hagestein, and upstream of the crossing point of the Amsterdam–Rijn Canal.

In order to reduce the flow resistance as well as the cost of dredging the bed to a lower level, it was decided to cut off two loops in the river Ijssel. One of these cut-offs, near Doesburg, has already been completed; the other, near Rheden, is scheduled for completion this year. These works also shorten the shipping route by several kilometres and remove two major obstacles to navigation.

Fig. 2 shows the levels in the northern arm of the Rhine before and after canalisation and also the bottom of the river bed. As may be seen, in spite of much research and extensive model tests, there remains a large measure of uncertainty with respect to the exact configuration of the bottom which will eventually become established as a result of silting and erosion. Since any changes in the depth of the river necessitate costly adjustments to the large number of groynes, any corrections will be carried out gradually and very carefully.

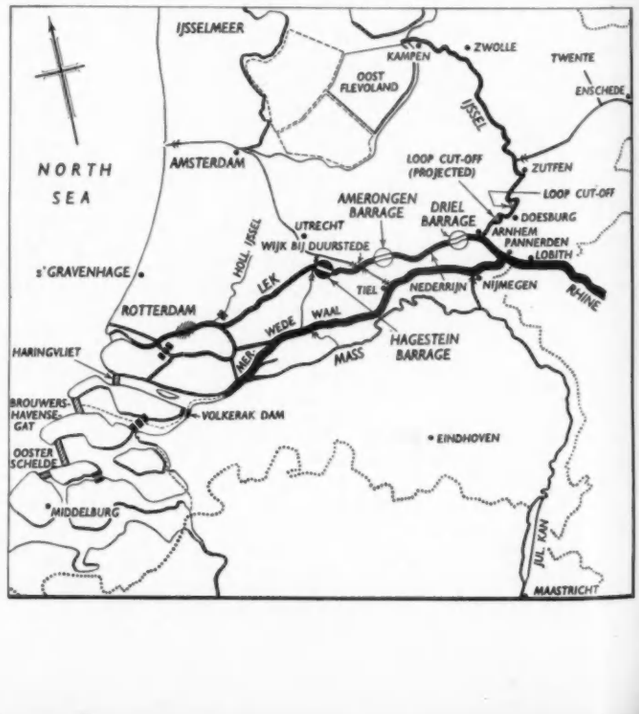
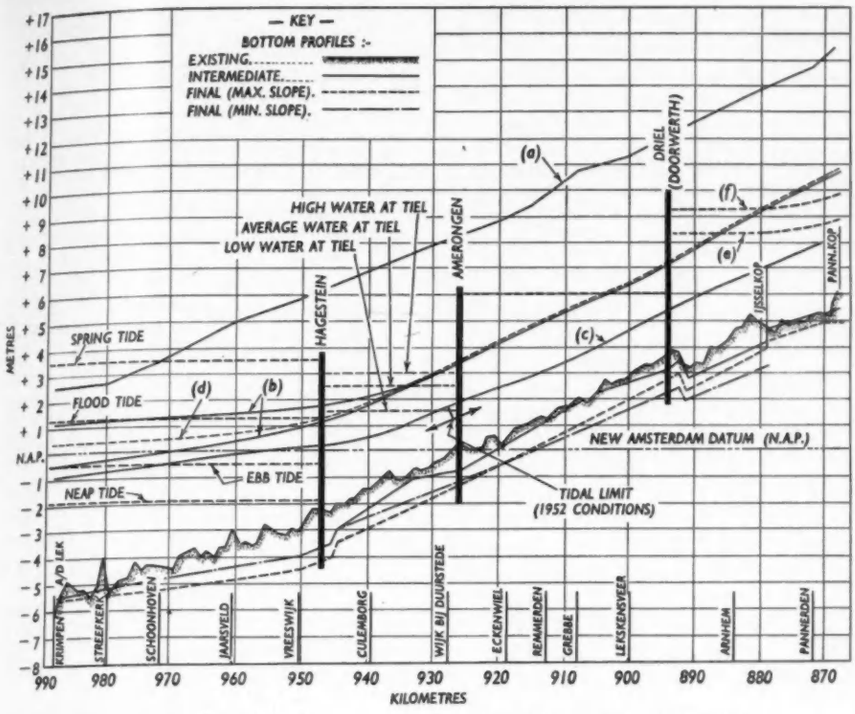


Fig. 1—Map of southern and central Netherlands with special reference to the area of the rivers Waal–Nederrijn–Lek and Ijssel

* THE ENGINEER, October 2, 1957, pages 337–352



River profiles—before construction of Rhine weirs.
(*a*) Flood conditions, 1926.
(*b*) Average, 1931–40.
(*c*) Drought conditions, 1952.
—after construction of Rhine weirs.
(*d*) Uncontrolled river*
(*e*) Impounding so that flow = 250 cumecs. †
(*f*) Impounding so that flow = 350 cumecs. ‡
* Under conditions of fully deepened river bed and a flow in the River Ijssel of 350 cumecs.
† Not reached on fifty days of the year.
‡ Not reached on 120 days of the year.

Fig. 2—Profiles of Lower Rhine/Lek

The twin weir and lock of Hagestein are situated about 3km upstream of Vianen, in a left-hand bend of the River Lek. The construction site lies entirely within the bend which will be cut off by a dam when the work is completed. Shipping will be assisted by the straightening which is involved. In order to bring the locks to the outside of the downstream bend where the water is deeper, they are placed to the right of the weir (i.e. to the north-east of it). This places the upstream lock entrance on the inside of the next bend, but model tests have shown that the formation of shallows here will be slight. Both the upstream and downstream approaches are to be made less curving. The length of the ship canals on each side of the lock system will be just under 1km, rather more than is the usual practice, so as to give ample time for barge trains to slow down and shorten their hawsers before tying up in the waiting bays. The latter are also amply dimensioned, the upstream bay being 150m long, and the downstream bay—since traffic up the river is expected to be the heavier of the two—even longer, viz. 200m. The dam which will cut off the old river will only be carried up to the height of the banks of the normal river bed, so that in very heavy floods when the inundation area is covered by water, some of this flow can use the old river bed.

A similar layout will be adopted at Amerongen where, however, two successive bends have to be cut off, thereby greatly increasing the cost. Although a cheaper solution has been proposed, model tests have shown that it is not satisfactory.

Because of the smaller width of the inundation bed at Driel it will not be possible there to construct both weir and locks in the same pit, as at Hagestein and Amerongen. It was therefore decided first to construct the weir on the left bank and divert the river to it, and then to build the locks in the old bed. Model tests proved this plan to be feasible under the heaviest known flood conditions.

Construction Pit

As soon as the general plan had been established by the Department "Upper Rivers" of the "Rijkswaterstaat" (Netherlands Public Works Authority), two other departments "Locks and Weirs" and "Bridges" were given the task to design the Hagestein works.

Construction of the working pit began in 1954. This pit, which enclosed both the weirs and the locks, measured approximately 400m by 400m and was surrounded by a temporary ring dyke of the same height as the inundation dyke, +7·00m above N.A.P.†

The subsoil consists of a slightly pervious layer of river silt with clayey sands which extend from ground level at +2m N.A.P. down to approximately +0·50m N.A.P. This is underlain by a medium to coarse, sandy, water-bearing layer extending to −3m N.A.P. followed by an almost watertight layer of clay reaching down to −7m, and in places to −9m N.A.P. Below, a fine to very coarse, sandy, water-bearing layer extends to a great depth.

† New Amsterdam Datum.

The watertight stratum between −3m and −7m N.A.P. divides the ground water into two regions. The upper, shallow ground water was kept away from the pit by a wall of sheet piling and did not require pumping out. The deep ground water necessitated the installation of fifty borehole pumps, each of 100 cubic metres hourly capacity, in 40m deep bores. The total installed capacity was 700kVA. This was the largest concentration of pumping capacity used in the Netherlands to date, being twice as much as was needed for the Velsen Tunnel. The cost of electricity for pumping amounted to 1500 guilders per day.

Before the central pier of the weir could be constructed, it was necessary to lower the water table to −15m N.A.P., while for the land abutments a more permanent lowering to −7·5m N.A.P. was required. The pit was excavated in the wet down to −5·5m and deepened further after having been dried out. A comprehensive survey of the neighbourhood was carried out beforehand in order to provide data for comparison in case lowering the ground water table should cause damage to buildings, dykes, or agriculture which might result in claims for compensation.

Our illustration (Fig. 4) shows the shipping locks and weir. Before describing the latter, a few words must be said about the layout and construction of the lock.

Lock

The top edge of the lock over its whole length is situated at +4·50m N.A.P., the same as its surroundings. This means that both the lock and the neighbouring area may be expected to be flooded about once in five years. However, as during flood periods the weirs are raised out of the water, the inconvenience of this is not such as to outweigh the extra expenditure which would be involved in providing protection against floods by raising the level to the full height of the inundation embankments, +6·50m N.A.P. The lower height of the sides of the lock is, in fact, of advantage in operation. In order to prevent floodwaters from causing damage by scouring, the height of the crown gate can be increased from +4·50m to +6·50m, and the space between the lock and the dykes on either side closed, by means of wooden doors mounted on rollers. While these doors are not watertight, they prevent water from streaming through.

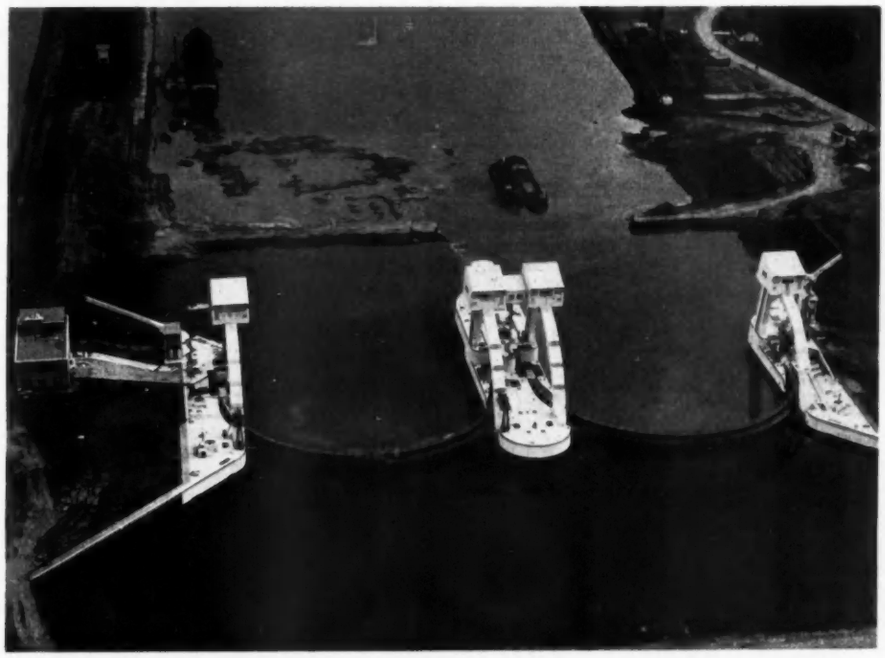


Fig. 3—Downstream view of Hagestein weir during construction. Part of the ring dyke has already been demolished

CONTINENTAL AFFAIRS *(Continued)*

The lock is equipped with three sets of steel mitre gates, there being besides the head and tail gates an intermediate pair of gates which divides the total useful length of 220m into sections of 90m and 110m. This arrangement helps to economise water in dry periods. The useful width is 18m. The gates are operated by hydraulic rams. During high storm floods it is possible for the lock to be subjected to a negative difference in water level of up to 0·2m, and the operating booms of the gates allow for this without the necessity to lock the gate halves together.

Filling time for the whole length of 220m, under a normal difference in level of 2·5m, is about eight minutes. The lock is filled through three sluice openings of 1·5m by 1·4m in each half-gate. A sill diverts the inflowing water so as to prevent the formation of eddies. Model tests were carried out to ensure that no abrupt change would occur in the force of the current on the ship, which in any case should not exceed $^1/_{600}$ of the tonnage. The crown gate is provided with a 1m wide gangway, the other gates with 0·6m wide gangways.

Installation of the gates, which weighed 30 tonnes apiece, was carried out with floating derricks after the lock had been filled.

Weir

Our illustration, Fig. 3, shows an aerial view of the Hagestein weir. From the point of design by far the most important part are the weir gates which span two openings of 48m.

The choice lay between a single span of 80m or two 48m spans. Smaller gates would tend to obstruct shipping and might cause ice to pile up. Since the cost of a gate varies approximately as the square of the opening, the solution with two gates was more economical.

The distance between the land abutments is 110m, and the two openings are separated by a 14m wide pier.

The gates are semi-circular, with the concave side facing upstream so that under the action of the water pressure the material is in uniform tension.

Gates of this kind but with a span of only 16m have previously been used in France at Bollène. Those gates lift vertically, whereas here they are pivoted at their ends and can be raised rather like the vizor of a mediaeval helmet. For that reason the term vizor gate has been coined for this design.

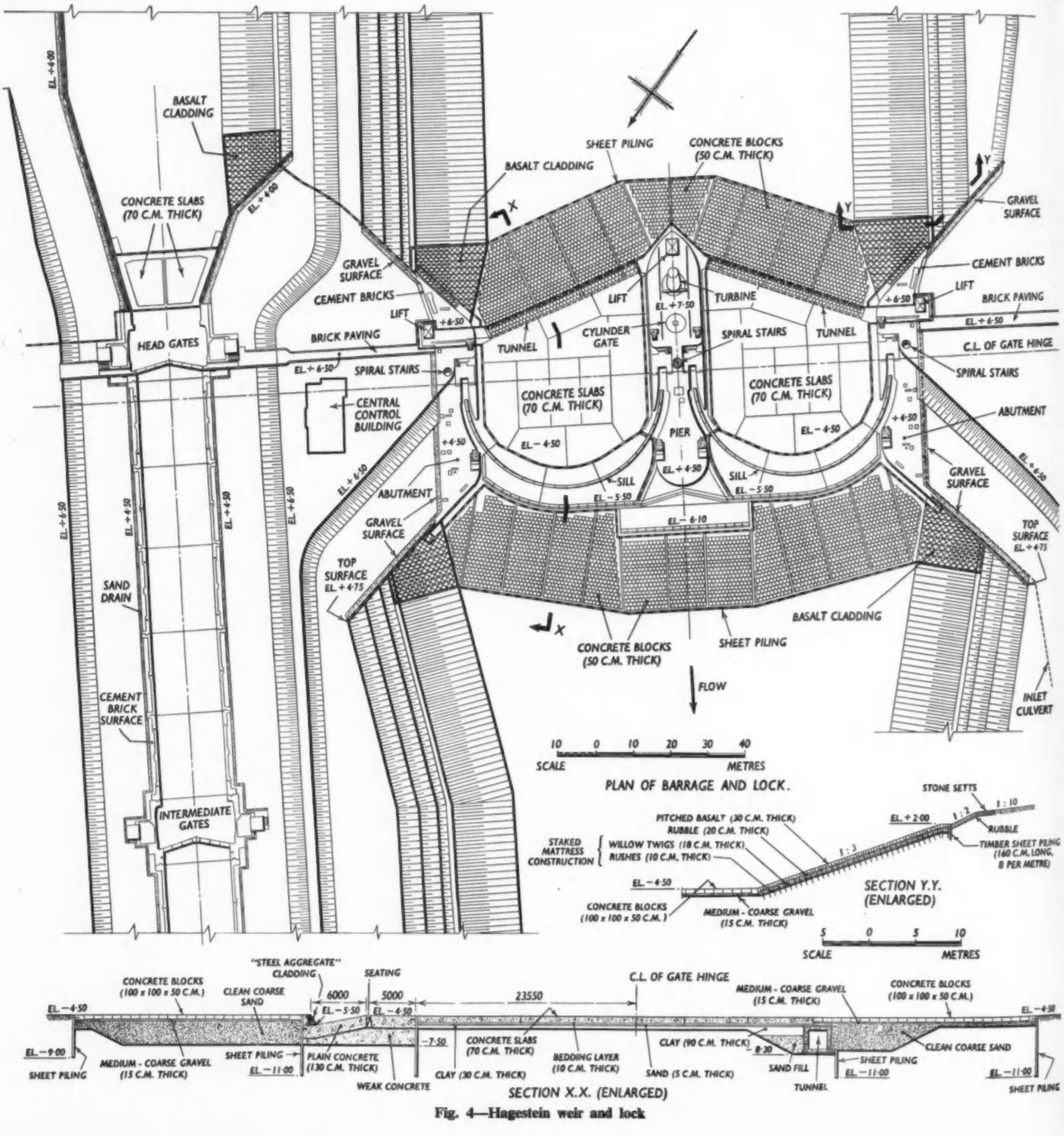


Fig. 4—Hagestein weir and lock

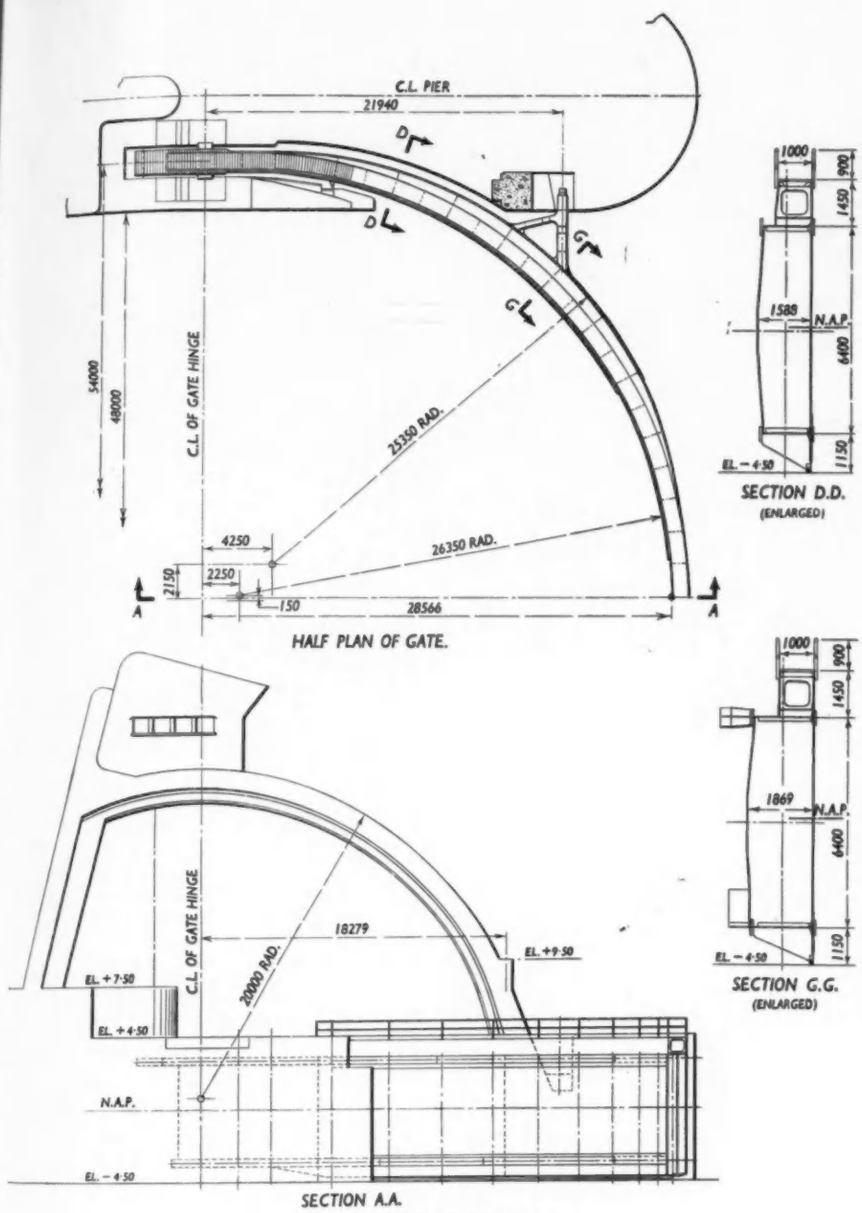


Fig. 5—Detail of vizor gate

The surface of each gate is a semi-cylinder, the original idea to design the gates with spherical surfaces having had to be abandoned on account of the higher cost.

Fig. 5 shows detailed views of one of the gates. Although the metal skin is by itself fully capable of withstanding the water pressure, in order to be able to raise the gate it had to be stiffened. This involved the incorporation of top and bottom flanges and vertical ribs as well as outer diagonal members (Fig. 6).

Each gate consists of two symmetrical halves joined at the centre by means of a vertical hinge (Fig. 7). This prevents temperature stresses from building up and also permits the gate to be folded inwards for dismantling. Each half comprises six prefabricated sections together with its portion of the central hinge section. Assembly of these sections at the site was done with high-tensile bolts. In order to erect the gates in the dry, eighteen submersion pumps had to be kept in operation.

The gate weighs 250 tonnes and the design water pressure is 1600 tonnes.

Various reasons led to the adoption of the vizor design. There is a saving in steel as compared with a straight lifting gate, and a lighter and lower superstructure can be used. From the hydraulic point of view also a semi-circular gate is advantageous. As model tests have demonstrated, the flow under the gate tends to be at right angles to the sill, i.e. in a radial direction. By spreading out the flow in this way there is less tendency for erosion to occur.

The bottom of the gate is provided with a rubber seal and the upstream side of the hinge is also covered with a sealing strip.

The four support trunnions are carried in pedestal bearings fitted with heavy roller bearings (Fig. 8). In order to protect the ends of the gates from collision with ships and from ice, they are housed in recesses in the abutments. Vertical seals are provided between the recesses and the inside faces of gates. These present a smooth surface, and, moreover, the arrangement has the advantage that the trunnion bearings are on the tail water side. With their C.L. only +0·75m above N.A.P. they have been submersed since the upstream side of the ring dyke was excavated in the final stage of construction, and will be submersed for a large part of the time when in use. The bearings are therefore fitted with a lip seal on the shaft, and a positive internal oil pressure is maintained from a raised filler tank. Scour culverts with sluice valves are installed which enable the bearing recesses to be cleared of deposits.

Hoists

The effort required to crack open the gate is the sum of the components in the direction of the lifting cables of deadweight, suction, and possibly an ice load of up to 80 tonnes : the design lifting force is 500 tonnes.

Vizor gates, as compared with lift gates, require only a comparatively light superstructure. Valuable space has been saved by placing the hoist machinery in elevated engine houses (Fig. 9). One result of this arrangement has been that the central pier could be made narrower than would have been the case with the machinery at ground level. This is important, as it makes it easier for ice floes to pass.

Each gate is operated by two hoists, one on either side. To raise it from the bottom position at 3 deg. to the horizontal to the top position of 60 deg. to the horizontal takes approximately 2½ hours. The drive is provided by 6 h.p., 1000 r.p.m. motors geared down in the ratio 1 : 1341·5. The motors represent a 100 per cent power reserve. Synchronism is maintained by selsyns.

The engine houses, which rise to a height of 28m above N.A.P., are situated on top of single concrete arches consisting of a quadrant and an inclined column. The hoist cables, of which three are four on each side, pass over three sets of pulleys mounted on the quadrant, and are attached to cantilever booms on the gate. Tensions are equalised by a system of balancer levers at the point of attachment.

In designing the gate, tests were carried out on a 1 : 25 as well as a 1 : 6 full size model in order to determine the period of vibration. With a structure of this kind the matter of vibrations is of considerable importance, and a further investigation is to be made on the actual gate with the help of about 100 strain gauges attached at various points. No wind tunnel tests were conducted.

Hydraulically actuated horizontal bolts, mounted on vertical swing links and situated near the cable attachments, allow the gate to be locked in the fully-closed position. Provision has been made for the fitting of clamping devices on the quadrant, if necessary. These would permit the gates to be clamped when partly or fully open.

The top of the weir is 3·30m above N.A.P., and the depth to the sill is 4·50m below N.A.P. Normally, clearance under the fully open gate exceeds 14·9m over a 38m wide section in the centre of the opening. At the highest known water level, the clearance is still 9·10m.

With a headwater level of 3·30m above N.A.P. and a minimum tailwater level of 1·80m below N.A.P. the maximum difference will be 5·10m. Operation of the weir will allow the headwater level to be kept to the required value within ±0·5cm.

The aim will be to maintain a draught of 2·8m, sufficient for ships of 2000 tonnes to 4000 tonnes ; minimum draught is to be 2·5m. On average, it is expected the barrage will be completely closed for one-third of the time, partially open for one-third of the time, and fully open for the rest.

When there is a threat of ice the weir will be opened to avoid a pile-up. It is also possible, as a result of storm floods entering from the North Sea, for negative differences in level of up to 0·2m to occur. As the gates are not built to withstand this they have to be raised. Ample warning will be available.

Foundations

The foundations of the lock extend down to 6·4m below N.A.P., while the intermediate layer of clay and peat extends locally to 7·8m below N.A.P. This weak material was removed and replaced by a mechanically consolidated sand fill. On this layer the 1·8m thick foundations could safely be placed.

A similar state of affairs existed at the abutment and pier foundations. Here too, any clay and peat soils were excavated and sand put down instead.

Weir Abutments

The abutment foundations extend down to −7·5m N.A.P., the 3m thick foundation slab being protected by sheet piling. In order to avoid a joint at the height of the pivots, the whole of the concrete work is carried up in one lift. Each abutment incorporates two fish-passes equipped with automatic flow control. One is for eels and consists of a series of 0·3m diameter pipes filled with brushwood. The openings lie

CONTINENTAL AFFAIRS *(continued)*

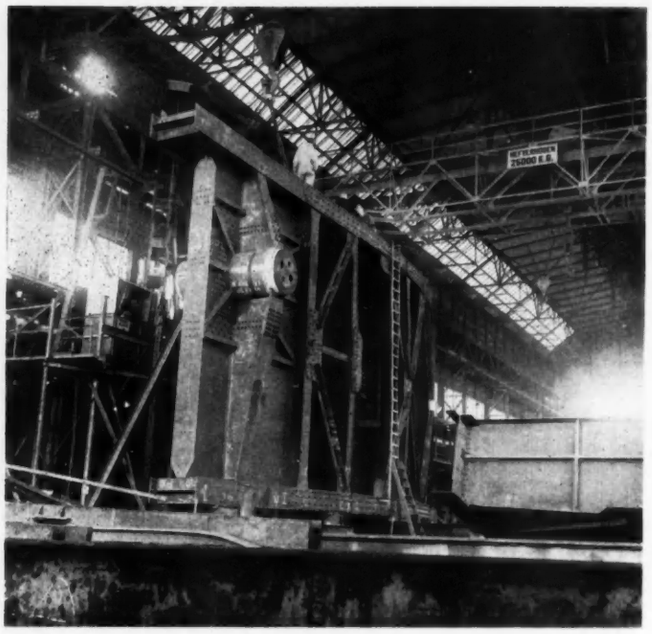


Fig. 6—Trunnion end of gate, seen from downstream side during assembly at the works

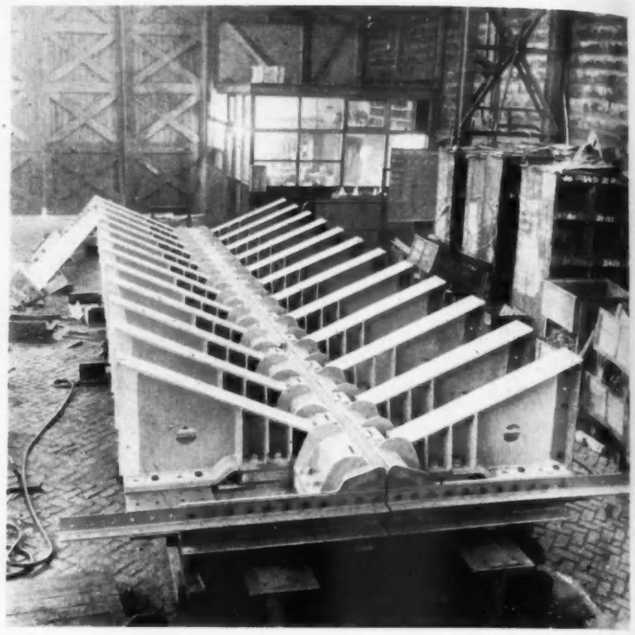


Fig. 7—Central hinge of gate at the maker's works, seen from the downstream side

towards the bank along which the eels migrate. The other is a fish-ladder for scaly fish with openings towards mid-stream. When the weir is closed, a strong current from these openings attracts the fish from the middle of the river.

Reference has already been made to the recesses for the ends of the vizor gates and the niches for the support bearings, and also to the desanding conduits by means of which the recesses are to be kept clear. The two 21-tonne pedestal support bearings are mounted on the vertical sides of opposite niches, so as to be in compression under the thrust of the water.

In addition, each abutment contains an adit to the tunnel which connects both banks by way of the central pier.

These adits consist of a cable shaft and a lift shaft. The abutments rise to 6·5m above N.A.P. over the upstream portion, while the downstream portion is only 4·5m above N.A.P.

Central Pier

The central pier (Fig. 9) contains recesses for the vizor bearings corresponding to those that are fitted in the land abutments. The presence of discharge passages for the turbine and fine flow control gate, the floor of which is 12m below N.A.P., made it necessary to extend the foundations to a greater depth than those of the land abutments, i.e. to 14·6m below N.A.P. Because of the intricate arrangement of passages in its interior the centre pier, which is approximately 70m long and 14m wide, has been nick-named the "snail's house."

The adit to the fine control gate lies on the side facing the left bank while the spiral turbine intake opens on either side.

The turbine lies immediately upstream of the fine control valve. It is a vertical Kaplan machine operating as a syphon turbine and designed for a maximum flow of 66 cumecs. Through a step-up gearbox it drives a 2·5MVA generator laid out for a power factor of 0·7. Estimated mean annual output will be 6,000,000 kWh. The machinery is placed in the open.

A total flow up to 150 cumecs will be discharged through the turbine and the fine control valve, after which the gates of the weir have to be brought into play. The fine control valve is a cylinder valve (bell valve) with spiral guide vanes in the inlet chamber.

A syphon turbine was chosen because it requires less depth for the discharge tunnel and there is also less tendency for the intake to silt up. The inlet openings are designed in such a way that normally there is no danger of floating debris being sucked into the turbine, or of air entering and breaking the syphon. For erecting and dismantling the turbine sections, which weigh up to 40 tonnes, a portal crane can be set up temporarily.

Turbine and valve intakes are protected by grilles and in case of ice can be closed by steel flaps which also serve as stop logs when the interior is to be drained. For the latter purpose the discharge tunnels are closed by water-tight wooden doors which normally are folded back into recesses in the walls.

The two discharge tunnels lie on either side of a central partition. Their outlets diverge in order to diminish scour.

Construction.—The pier foundation slab is 2·5m thick, 17m wide and 72m long. The whole was cast in one piece with the help of a travelling conveyor with a capacity of 50 cubic metres of concrete per hour.

In the 7·5m high second lift, 4800 cubic metres were poured in one continuous operation. This includes the two discharge tunnels for which the doubly-curved timber shuttering had been prefabricated and brought to the site in sections by ship.

Perhaps the most complicated portion of the work was the third lift which included the intakes for the turbine and cylinder gate valve and the recesses for the weir gates. Erection of the shuttering, which again had been prefrabricated in the workshop, occupied five months of intensive work. A volume of 4700 cubic metres was continuously cast in seven days at the rate of 30 cubic metres per hour until the up to 11m high section had been completed.

Superstructure

Another unusual aspect of the weir are the four hoist towers with their concrete quadrants of 20m radius. The upper end of each quadrant is supported by an inclined column. In the angle between the extension of the column

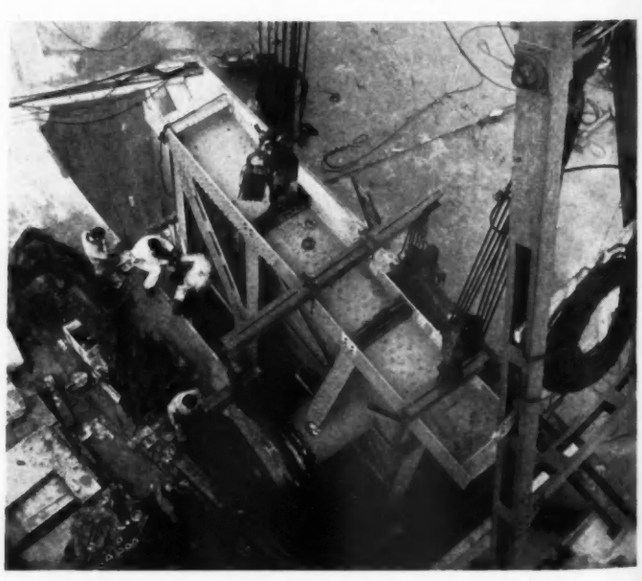


Fig. 8—Positioning one of the pivot ends of a visor gate in its recess on the pier

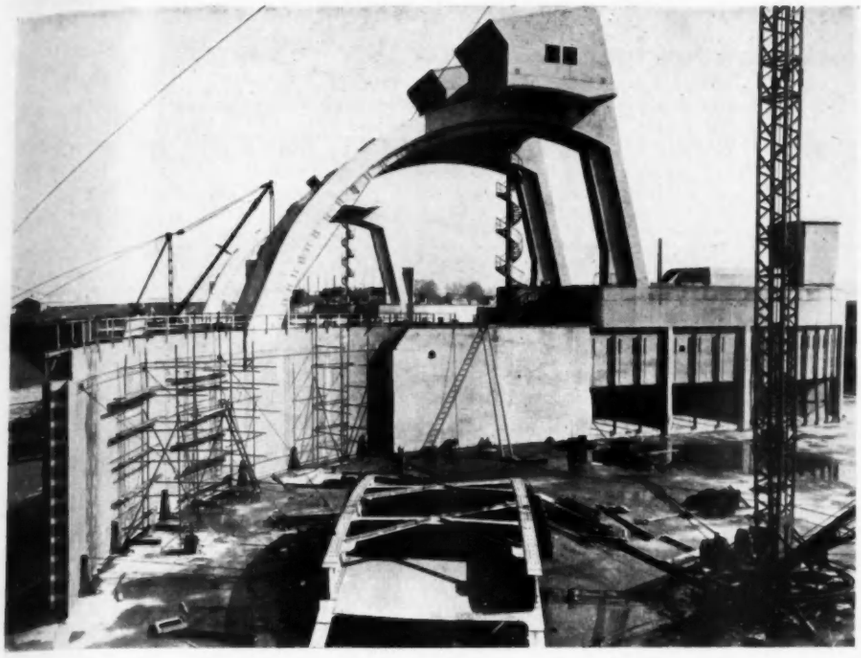


Fig. 9—Left weir gate under construction showing the jacks and guy ropes which hold the prefabricated sections in position. The half-gate is nearly complete except for the hinge. On the central pier the recess for the gate pivots is clearly seen, also the double intake of the cylinder gate (left) and one of the turbine intakes (right), and two of the hoist arches

above the quadrant, and the quadrant itself, perches the hoist building, also of concrete. The two buildings above the pier are interconnected. Access is by way of iron spiral staircases.

Quadrants and supports were cast in one piece. The heaviest part was the base for the hoist building. Shuttering for this base rested on a trestle with four columns at the corners and diagonal struts, somewhat like two inverted letters " M " standing side by side. The platform was extended in the upstream direction and on this part was supported the shuttering for the hoist column. At the opposite (downstream) end the shuttering for the quadrant was linked on, supported by one set of struts set approximately at 45 deg. to the horizontal, the top ends of these struts being connected by tie members to the bottom and top ends of the quadrant.

The casting required 300 cubic metres of concrete and proceeded continuously over twenty-four hours. Creep of the concrete during hardening had to be accommodated, and this was done by resting the top end of the quadrant shuttering on the hoist platform in such a way as to allow horizontal movement. The ends of the shuttering abutted against a transverse steel joist which was anchored by tie bolts to the platform edge. The necessary adjustments could be made by slackening the nuts of the tie bolts. The shuttering was struck after a fortnight when the concrete had reached a compressive strength of 250 kg per square centimetre. Then the shuttering for the hoist buildings was set up.

Tunnel

Electric connections with the hoists, generator, &c., are made through a tunnel which connects both banks and the pier. This tunnel was constructed as a pedestrian subway with lifts to ground level at either end and at the control pier. It gives access to the centre pier when the gangway over the gates is unusable on account of the weather or because the gates are up.

Built in an excavation extending to 8·30m below N.A.P., the tunnel was constructed in 16m long sections measuring 3m by 3m externally. The internal shuttering was supported in such a way as to enable each section to be cast in one piece. The joints have two grooves, one for a coconut fibre rope and the other for a strip of synthetic rubber bonded to steel strips. The whole tunnel is covered by a double layer of asphalt composition protected by brickwork. On the upstream side, a curtain of sheet is pile-driven to 11m below N.A.P.

Apron

Between the land abutments and the pier, the river bottom is protected by 0·7m thick concrete slabs placed on 0·9m of clay and a 0·1m thick bedding layer (Fig. 4). The clay is impervious and the section is protected by sheet piling at both ends. The weight of the slabs is capable of resisting an uplift of 1·5 tonnes per square metre. This section is followed on the downstream side by the double gate apron, two crescent-shaped blocks of 1·3m thick concrete resting on a base of weak concrete extending down to 7·5m below N.A.P. The two crescents are joined by the discharge apron of the pier, and the whole is enclosed between walls of sheet piling. Above the actual gate sill the concrete is level while below it falls away to form a stilling basin terminated by a steeply counter-sloping second sill. Both sills are constructed of precast elements made specially wear-resisting by the use of steel aggregate.

Both downstream of the stilling sill, and upstream of the tunnel, the river bed consists of coarse sand ballasted against scour by heavy blocks of concrete 0·5m thick and 1m square. These sections also are terminated by curtains of sheet piling extending right across the river.

Timetable

In 1954 a start was made with the construction of the first works such as dykes, quays, and embankments, in the southern foreland of the River Lek near the village of Hagestein. On October 31, 1955, the first work was completed. By the beginning of 1956, part of the building pit had been completed down to 5·5m below N.A.P., and the ring dyke was finished. Including auxiliary works, i.e. river improvement, weir canals, &c., this part of the work involved an expenditure of over fl. 6·3 million. Tenders for the construction of the lock, as well as for the weir complex, were invited at the end of July, 1956. The lock was substantially completed by May, 1958, and its approaches and operating buildings were ready by January, 1959. Following substantial completion of the abutments and the pier at the end of 1958, the following year saw the construction of the concrete superstructures, sills, and revetments of the river bottom, and the installation of the fish passes in the abutment blocks. The weir control building was erected, and during the winter of 1959–60 the two vizor gates were fitted. With the installation of the machinery in 1960–61 and the removal of the ring dyke the weir became ready for use. Finally, the old course of the river will be blocked by a dam.

Quantities

The total amount of sheet piling was 3000 tonnes and the combined length about 30km. Reinforcement steel amounted to 4000 tonnes. About 800 concrete piles varying from 9m to 11m in length were manufactured at the site. The total volume of concrete is 65,000 cubic metres. The overall cost of the Hagestein complex will amount to approximately fl. 40,000,000.

Design and Main Contractors

Management " Upper Rivers " of " Rijkswaterstaat ": Overall plan, construction of building pit and adjoining river works.
Managemen ," Locks and Weirs of " Rijkswaterstaat " : Design and construction of Hagestein complex.
Management " Bridges " of " Rijkswaterstaat ": Design of weir gates.
Werkspoor N.V., Utrecht.—Construction of weir gates.
N.V. Stork, Hengelo : Turbine and generator.
Hillen & Roosen N.V.: Concrete works.

High-Speed Tests with Silicon Rectifier Locomotive

On May 4 and 8 the French National Railways carried out high-speed test runs between Strasbourg and Mulhouse with the B_0B_0 locomotive No. 20103, which has been equipped by the Materiel Electronique Schneider-Westinghouse with silicon rectifiers (see our August 12, 1960, issue). The object of the tests was to observe the performance of the locomotive while running at 118 m.p.h. for as long as possible on this 67-mile journey, and to record the behaviour of the 25kV a.c. overhead system. On the final run the distance was covered in 40 min. 20 sec., at a start-to-stop average of 100 m.p.h., and speed was held between 115 and 118 m.p.h. over a total distance of 37 miles. Speed limits were observed of 112 m.p.h. through Sélestat, 93 m.p.h. at Colmar, and 87 m.p.h. for 1km in a region of mining subsidence. The load was 217 tons (four coaches and a dynamometer car). In its present form the locomotive weighs 82 tons, a reduction of 3 tons compared with its weight as originally built with mercury-arc rectifiers.

The Faiveley pantograph on the locomotive was fitted with a collector head having a " U " shaped support offering an aerodynamic resistance of 23 lb at 118 m.p.h., as against the 34 lb of the original collector and support. On the final run of May 8 the working voltage was raised from 900V to 950V per motor to counteract the retarding effect of a 16 to 19 m.p.h. side wind. The two traction motors are connected permanently in series. After passing through Strasbourg station at 19 m.p.h., speed reached 71 m.p.h. in 56·5 sec., and attained 118 m.p.h. in 6 min. 13½ sec. after travelling approximately 10¼ miles. Energy consumption at the pantograph was 1440kWh, representing an average power of 2150kW and of 2550 h.p. at the wheel rims. The maximum power at starting was 6000kW at the motors, or 7500 h.p. at the wheels. Vertical and transverse forces recorded in the leading cab did not exceed 0·25*g*.

No modifications were made to the overhead contact system. Records were made of the movements of the catenary by cameras at the trackside and by an oscillograph in the locomotive. This was the first continuous high-speed test to be reported on the French National Railways 25kV, 50 c/s system, and the maximum speed was the highest yet attained with a French locomotive having single-motor bogies.

Second International " Pro Aqua " Exhibition in Basle

The second " Pro Aqua " Exhibition will be held on the premises of the Swiss Industries Fair in Basle from September 30 to October 7 this year. A great number of exhibitors from various countries have already signified their intention to take part in this specialised fair devoted to the problems of water supply, waste water purification, refuse disposal, &c. A series of scientific lectures with simultaneous translation has been arranged to take place during the period of the fair ; twenty-five lecturers from ten countries will be talking on various subjects connected with water, its use, purification and protection.

THE AMERICAN SCENE

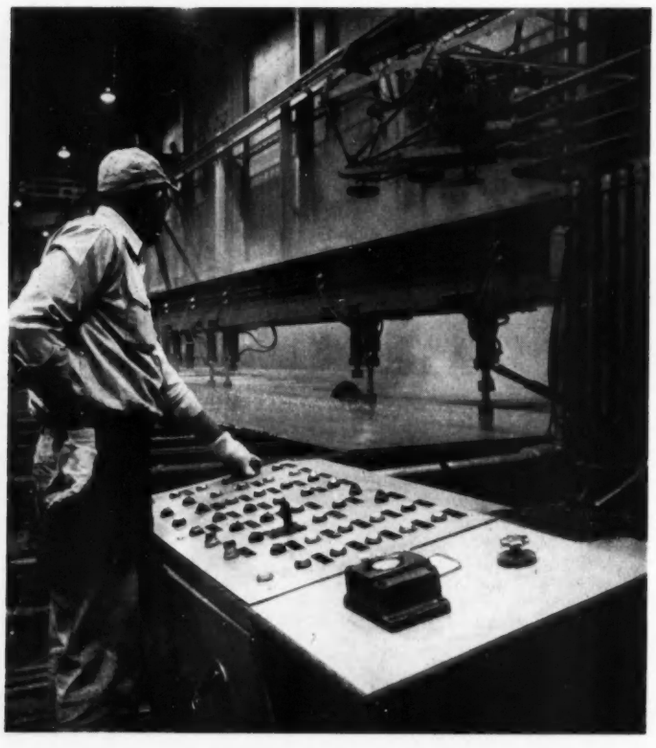
By Our American Editor

Sawing Machine for Large Light Alloy Plates

A highly automated circular sawing machine for aluminium alloy plates recently went into full production at the Kaiser Aluminium and Chemical Corporation's Ravenswood Works in West Virginia. With a capacity to handle material up to 64ft long by 14ft wide by 6in thick, the saw is believed to be the world's largest installation for trimming and subdividing light alloy plates. Its operation is closely related to that of an adjacent plate stretcher having a record-breaking 30,000,000 lb pull capacity. While a wide variety of aluminium alloys is processed by the plate stretching and sawing installation, there is particular emphasis on the 5000 group which offers optimum performance in many heavy-duty applications. This series includes the strongest non-heat-treatable American aluminium alloys and offers high yield strengths in the annealed state, permitting efficient welded fabrication methods.

The entire sawing facility was designed and built by the Loma Machine Manufacturing Company, of New York, in close co-operation with the Kaiser Aluminum Advanced Engineering Design Section. It comprises a 64ft travel rip saw, a 14ft travel cross cut saw and a 14ft travel end trim saw, all integrated to facilitate simultaneous operations. The highly automated plate handling equipment comprises a charging table for entering the stock into the rip saw, a delivery table for removing the stock out of the rip saw into the cross cut or end trim saws, and a runout table for discharging the finished plates. In operation, each plate is loaded by crane onto the charging table receiving racks which are clad with Micarta. The plate is moved into the rip saw path by an automatic pusher drive which cuts out as soon as a series of stops on the delivery table are hit. At this instant the air-operated hold-down clamps located on both sides of the saw path are lowered, the length stops in the table disappear, the air-oil mist lubrication system is turned on, and the rip saw begins to make its cut. The 64ft long rip saw employs a 30in diameter carbide-tipped sawblade driven by a 60 h.p. motor at a peripheral speed of 12,000ft per minute. Feed rates of 5ft to 45ft per minute are available during the cutting cycle, and there also is a 200ft per minute rapid return rate. The cross cut and end trim saws are all similarly designed, except that their length of cut is only 14ft.

Once the rip saw cut has been completed, the hold-down clamps open and the cut plate is moved out of the saw path by a set of belt conveyors. Subsequently, it is transferred by means of the reversible delivery table rollers, to be similarly cut by the cross cut and/or the end trim saws. Finally, the plate is moved onto the runout table, which is equipped with driven transfer rollers. It is now ready for crane pickup, to be transferred to the shipping or heat treating bay.

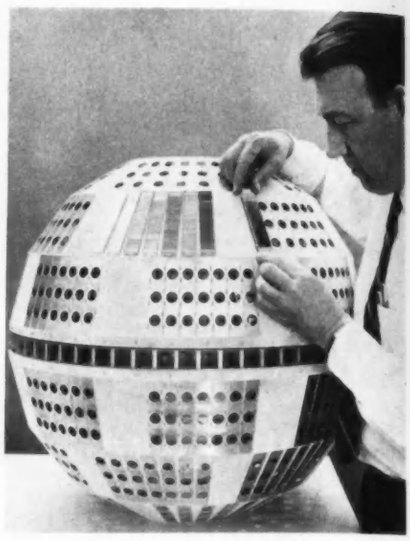


Loma circular sawing installation for aluminium alloy plates at the Ravenswood Works of Kaiser Aluminium

Sapphires for Satellite Protection

In giving the fifteenth annual Charles M. Schwab memorial lecture to the American Iron and Steel Institute, Dr. James B. Fisk, President of the Bell Telephone Laboratories, described measures to be taken to protect the solar cells of the first communications satellites from the effects of electron bombardment in space.

Until now, said Dr. Fisk, most satellites had been designed for short-term experiments in space. Bell engineers had set as their goal the production of satellites that would work dependably for many years, serving as radio relay stations for communications overseas. A ground station in Maine for a satellite communication system would be ready early next year. The first test satellite would be ready at the same time if the Government designated a launching vehicle soon. The first experimental phone satellite would be roughly spherical, but might have as many as sixty flat surfaces, or facets. The solar cells on each facet would receive an equal amount of light. A sapphire sheathing would protect the solar cells from the deteriorating effects of electron bombardment in space, and reduce the effects of proton bombardment. Two different sizes of test satellite, with diameters of 27in and 4ft, were being considered for experiments. More than half the surface of the smaller one would be covered by over 4000 solar cells, and that of the larger satellite by 12,000 cells.



Solar cells with a sapphire protective covering against radiation being fitted to a communications satellite

Covering the cells would be an equal number of slices of man-made, crystal-clear sapphire. Other protective materials were not being ignored, although sapphire appeared most promising. The sapphire did not cost significantly more than other high-quality materials that might be used, and was only about one-third of the cost of the solar cells themselves. Sapphire had other advantages. For one, it would convey heat away, preventing the solar cells from being overheated in long periods of continuous sunlight. Another advantage was that the use of sapphire overcame the effects of very rapid and extreme changes of temperature in space. The sapphire slices would be brazed to platinum sidebars which would be soldered to a ceramic base. These materials were selected because they all expanded at very nearly the same rate. In addition, sapphire would resist erosion by micrometeorites.

Under the reliability approach evolved in the development of submarine cable and other systems, said Dr. Fisk, the goal was to ensure a predictable long life for the entire system. First, the environment must be studied. Then, in a simulated environment, the hazards were intensified to make the components fail. Unfortunately, the space environment was not yet known precisely. The exact amounts of radiation in space at various altitudes and under varying circumstances had not been measured. Therefore Bell Laboratories engineers planned to use their first experimental satellite both to take additional measurements of space radiation and to serve as a first "real-life test" of components for a working satellite system.

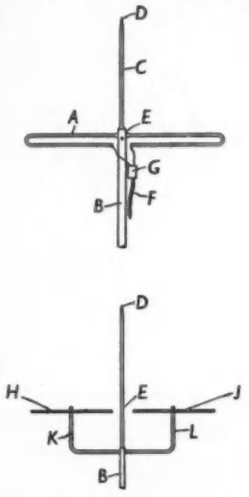
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

TELECOMMUNICATIONS

868,424. December 10, 1958.—RECEIVING AERIAL SYSTEMS, The British Broadcasting Corporation, Broadcasting House, London, W.1. (*Inventor : George Dewar Monteath.*)

The present invention has for its principal object to provide means for reducing the effects of what is known as precipitation static in receiving aerial systems. Precipitation static may take various forms. For example, discharges can take place from the aerial or from a neighbouring metal structure. Precipitation need not be occurring at the time when this effect is observed, but it is usually occurring somewhere in the vicinity of the receiving point. Again, it may happen that there is a d.c. field at the surface of the aerial (or a structure to which it is coupled), but that this is not strong enough to cause a discharge. If the aerial or the structure is then struck by raindrops, impulsive interference will be caused even though the drops may carry no charge. On making contact with the aerial, or approaching sufficiently closely for a spark to pass, each drop will form a temporary protuberance on the aerial and must therefore acquire a high charge density from it. Three embodiments of the invention are described in the specification. The one illustrated in the upper drawing takes the form of a folded horizontal half-wave dipole *A* carried upon a metal supporting pole *B*.



No. 868,424

A discharge conductor *C* extends vertically upward from the end of the pole *B* in the equatorial plane of the dipole. The tip *D* of the conductor *C* is pointed whereas the metal member forming the dipole *A* is made as free from sharp points as possible. The length of the discharge conductor *C* is such that its tip *D* is at least as far from the centre *E* of the elements or limbs of the dipole *A* as any part of these limbs. Because of this and because of the pointing of the tip *D*, the discharge conductor *C* is likely to accept substantially all the discharge which takes place. If precise symmetry is preserved between the two limbs of the dipole, currents on the discharge conductor produce negligible potential differences at the aerial terminals and hence no noise arising from such discharge will pass to the aerial terminals. It is important that the effect of symmetry be not destroyed by the method of connection of the aerial to a receiver. Thus, in the drawing, a coaxial feeder *F* is used for this connection and a balance/unbalance transformer *G* is provided. If desired a balanced feeder may be used, but it is then necessary to ensure that push-push currents are rejected at the receiver and that the receiver responds only to push-pull currents. The folded dipole may be replaced by a straight dipole. The arrangement shown may be extended to aerial arrays such as Yagis or vertically stacked dipoles in which the dipoles have a common equatorial plane. The discharge conductor is, as in the drawing, arranged to extend to a point at least as far from the centre of the aerial array as any part of the aerial array. With a broadside array of horizontal dipoles, separate discharge conductors may be provided for the individual dipoles, but unless the dipoles are supported on separate vertical poles it is difficult to prevent noise currents from flowing horizontally at some point and being coupled into the dipoles. The arrangement shown in the lower drawing avoids the difficulty. Two horizontal halfwave dipoles *H* and *J* are supported upon a pole *B* by supports *K* and *L*. Again, the tip *D* is arranged to be at least as far from the centre *E* of the aerial elements *H*, *J* as the tips of these elements, and the tips are preferably rounded whereas the tip *D* is pointed. The arrangement can be applied to a broadside array of horizontally-polarised Yagi aerials using a single discharge conductor whose extremity is at least as far from the centre of the array as any part of the array. The third arrangement described in the specification comprises two folded vertical dipoles.—*May* 17, 1961.

RAILWAY SIGNALLING

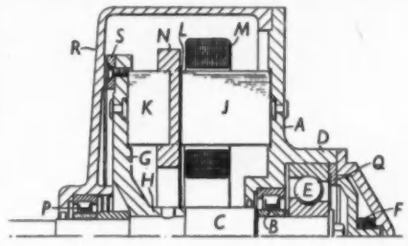
868,052. June 27, 1956.—VEHICLE SIGNALLING SYSTEMS, The Siemens and General Electric Railway Signal Company, Ltd., East Lane, Wembley, Middlesex, and Paul Joseph Barker and Hubert John Napier Riddle, both of that company.

This specification describes a number of systems for automatic train control in which the locomotive apparatus includes a magnetron. This is provided with an a.c. anode supply from which a d.c. component is obtained by the rectifying action of the magnetron. When the apparatus passes a signalling position along the track, the magnetron first passes through the magnetic field of a permanent magnet and then through the magnetic field of an electromagnet, both mounted to lie vertically between the running rails. When the magnetron passes through the field of the track permanent magnet, an electromagnetic relay in the apparatus which had previously been operated is released. The relay remains in this position until the magnetron passes through a magnetic field due to the track electromagnet, which field is in the opposite direction to that due to the track permanent magnet, whereupon the relay is re-operated. This is the condition of the magnetic fields when an " all clear " signal is to be sent to the train while if a " danger " signal is to be sent. the track electromagnet is either not energised or is energised to give a magnetic field in the same direction as the permanent magnet with the result that the said relay which is not therefore re-operated is arranged to give a danger indication or sound an alarm. A form of magnetron is used in which the anode current is dependent upon the strength of the magnetic field in which the magnetron lies in a direction parallel to the axis of the magnetron. As the strength is increased from a relatively low value, there is at first very little change in the anode current but further increase in magnetic field beyond a particular value results in the anode current rapidly decreasing to zero. It is this rapid change in anode current for a relatively small change in magnetic field strength that is made use of in the examples of apparatus under consideration. A flux collector plate is mounted underneath the locomotive, while a pair of pole pieces lie one on either side of the magnetron, in line with its axis, and these pole pieces provide magnetic paths to the collector plate and to the body of the locomotive respectively. When, therefore, the collector plate is over the track permanent magnet, for example, a portion of the magnetic flux due to that magnet is concentrated by means of the collector plate and the pole pieces so as to traverse the air gap in which the magnetron lies. The invention is not confined to railway signalling systems. If the magnetron is located at a particular point along a railway track the system may be adapted to respond to changes in the magnetic field resulting from the passage of a locomotive or train. Such a system may be used for axle-counting, while a somewhat similar system may be used in road signalling to detect the passage of cars and lorries.—*May* 17, 1961.

ELECTRICAL ENGINEERING

868,513. February 23, 1959.—AXIAL AIR GAP DYNAMO ELECTRIC MACHINES, Limit Engineering Group, Ltd., 64, Essex Road, London, N.1. (*Inventor : Kenneth Martin Nicol.*)

This invention relates to dynamo electric machines of the axial air gap type and has for an object the provision of a machine which is of simple construction and which incorporates a brake that comes into action automatically when the machine is de-energised. The improved motor comprises a stator frame consisting of a flat disc-like member *A* (see drawing) having a central housing for one journal bearing *B* of the motor shaft *C* and on one face a central tubular extension or hub *D* providing a housing for a thrust bearing *E* and spring biasing means *F*. The rotor frame also consists of a flat disc-like member *G* having a central tubular portion *H* secured on the motor shaft. The two frames support on their facing surfaces respective cores of magnetic material *J*, *K* which are arranged with an air gap *L* between them extending in a plane normal to the rotor axis. Both cores are formed in their facing surfaces with suitably



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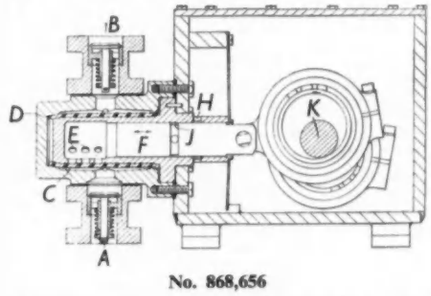
disposed slots which extend more or less radially across the cores and house the necessary windings *M*, *N*. In operation, when the motor is energised the magnetic flux between the rotor and stator cores produces magnetic attraction between them which causes them to be pulled together, thereby to move the rotor shaft in its bearings *B*, *P* with a force which is greater than that provided by the spring means *F* to close the air gap to a minimum dimension determined by the thickness of washer *Q*. When the motor is de-energised, however, the spring *F* causes the rotor and shaft to move in the opposite direction, that is to the left in the drawing, and to bring the faces of the rotor frame and cover member *R* into contact through the friction material *S*. Consequently a braking force will be applied to the rotor and to the external load as soon as the motor is de-energised.—*May* 17, 1961.

PUMPS

868,656. July 6, 1959.—DIAPHRAGM PUMPS, Cecil Hughes, Teffont Magna, Salisbury, Wiltshire.

This invention is especially applicable to pumps for gases, liquids or semi-liquid materials. The



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drawing shows a vertical section through one cylinder of a twin pump. Each of the pumps has an inlet *A* and an outlet *B* fitted with spring loaded non-return poppet valves. The pumping chamber is in the form of an annular space formed within a cylindrical housing. The pumping space *C* is completely sealed off except through the inlet and outlet and the interior wall of the annular pumping space is formed by a short length of hose *D*, the ends of which are sealed. Each of the twin pumps is operated by the expansion of the hose to occupy the pumping space followed by the contraction of the hose into the position in which it is shown in the drawing. It will be appreciated that the expansion of the hose to obtain a pumping stroke may be obtained in many ways, for example, by the application of hydraulic or pneumatic pressure to the interior of the cylinder which is permanently closed at one end and thence through the apertures *E* to the interior walls of the hose. In the embodiment of the invention illustrated, this pressure is obtained by means of a ram *F* oscillated within the cylinder. As the ram advances, from right to left, liquid will be forced through the holes *E* to expand the hose and as the ram moves in the opposite direction, the liquid returns and draws the hose close to the outer surface of the cylinder. At all times the hose will be subject to an equal and opposite fluid pressure upon its sides so that it is not subject to any heavy loading. In order to ensure that any leakage of fluid past the ram is replenished, the outer end of

the cylinder in which the ram and its extension oscillate is provided with apertures *H*. These apertures come into alignment with an annular groove *J* in the ram immediately before it starts upon the pressure stroke of the pump. The annulus connects through a suitable bore to the front of the ram so that oil is free to pass. As the ram starts upon its pressure stroke, the annulus *J* moves out of alignment with the aperture to seal the liquid in the front of the cylinder. By this means it can be ensured that the cylinder is always filled and the pressure of liquid at any point upon the stroke of the pump is always constant. If desired, this arrangement can also be utilised to vary the pumping capacity of the pump. Thus, if the main shaft *K* is so carried that it may be moved axially relative to the apertures *H*, then the effective starting point of the operative stroke of the pump—that is the point when the annular groove passes the apertures—can be varied. By this means the amount of fluid in the chamber can be varied and in consequence the degree of expansion of the hose.—*May* 28, 1961.

COAL CARBONISING PLANTS

868,567. February 1, 1960.—TREATMENT OF EFFLUENTS FROM COAL CARBONISING PLANTS, Gas Council, 1, Grosvenor Place, London, W.1. (*Inventors: William Henry Blackburn and John Raymond Catchpole.*)

In previous Patent No. 804,544 there is described a process for the treatment of aqueous effluent liquors from carbonising plants in which such a liquor, which has been treated for the removal of free ammonia, is subjected to biochemical oxidation and subsequently distilled with lime to remove fixed ammonia. It has now been found that the liquors may advantageously be given a final treatment with activated carbon. This final treatment reduces the permanganate value of the liquor and also improves its colour. It has also been found that when the activated carbon treatment is applied to liquors which have been treated by the process, the life of the carbon is increased as compared with its application as a final treatment to liquors from which both free and fixed ammonia have been removed prior to its biochemical oxidation. This increase in the life of the activated carbon renders the final treatment with activated carbon a much more attractive proposition from the economic point of view. The invention accordingly consists in a process for the treatment of aqueous liquors from coal carbonising plants, which comprises subjecting such a liquor, which has been treated for the removal of free ammonia, to biochemical oxidation, distilling the resulting liquor with lime to remove fixed ammonia and finally treating the liquor with activated carbon. The activated carbon treatment may be carried out by passing the liquor up through a column (or columns) packed with activated carbon particles so that the column is always full of liquor, but is preferably carried out by percolating the liquor down through the column without actually flooding it. An additional reduction in the permaganate value of the liquor and a further improvement in its colour may be obtained, by acidifying the liquor after the distillation with lime carbon, preferably to a pH of about 2-4. Sulphuric acid or hydrochloric acid may be used for this purpose. The biochemical oxidation step of the process destroys phenols, thiocyanate and thiosulphate present in the liquor subjected to this treatment.—*May* 17, 1961.

METALLURGY

869,010. March 20, 1958.—ALLOY STEELS, Crucible Steel Company of America, Post Office Box 88, Pittsburgh 30, Pennsylvania, United States of America.

This invention pertains to an age hardenable austenitic steel having good hot formability as solution annealed and which can be hardened to at least "C" 38 Rockwell on solution annealing at a relatively low temperature within the range of 2100 deg. to 2150 deg. Fah., and thereafter aging for a relatively short time, i.e., about eight to sixteen hours at about 1350 deg. Fah. In addition, the steel is stated to have good impact strength, stretch resistance and creep-rupture strength at temperatures up to at least 1350 deg. Fah. It resists corrosion from the combustion products of leaded fuels, and is particularly adapted for valves and valve parts of internal combustion engines. The steel of the invention contains relatively high carbon, within the range of 0·4 to 1 per cent, together with chromium, nickel, manganese and vanadium, all as essential constitutents, in critically limited amounts and in balanced proportions. The steel may contain up to 0·5 per cent silicon, but the silicon should not exceed 0·3 per cent for internal combustion engine valve applications. The molybdenum content should be less than 0·1 per cent for valve applications and up to 0·4 per cent nitrogen, but preferably the nitrogen content does not exceed 0·25 per cent. The broad and preferred ranges of analysis of the steels of the invention are given in detail in the specification.—*May* 25, 1961.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

PERMISSIBLE STRESS IN CRANES. PART 1: STRUCTURES

ELECTRIC OVERHEAD TRAVELLING CRANES FOR GENERAL USE IN FACTORIES, WORKSHOPS AND WAREHOUSES

No. 2573 : 1960, Price 12s. 6d., and No. 466 : 1960. Price 10s. Revised editions of these Standards for cranes have been issued.

B.S. 2573 has been revised as a result of experience gained since it was first published in 1955 and the new edition is intended to form the basis for the design of all types of cranes. The standard has been considerably expanded to include guidance on many aspects not dealt with in the 1955 edition, including fluctuations of stress, basic stresses in bending for lattice girders and trusses, effective lengths of struts, basic shear stresses in web plates and minimum thickness of web plates, and the proportioning of web stiffeners. Metric versions of the tables are included as an appendix.

B.S. 466 has also been extensively revised and now classifies cranes according to their intended duty; it also requires the crane structure to be designed in accordance with B.S. 2573. Two significant innovations are that, where a rail is adequately secured to a crane girder it may now be regarded as part of the girder for load carrying purposes, and that the maximum deflection permitted is now related to the combined weight of the safe working load and the crab.

TUBULAR HEAT EXCHANGERS FOR GENERAL PURPOSES

No. 3274 : 1960. Price 20s. This much-needed British Standard specifies minimum requirements and gives guidance for the mechanical design and construction of shell-and-tube heat exchangers, a specialised form of pressure vessel widely used in industry for such purposes as heating, cooling, evaporating and chemical reaction. Information supplied by the Tubular Heat Exchanger Manufacturers' Association (T.E.M.A.) and the American Society of Mechanical Engineers has been used in the preparation of the standard and the recommendations of B.S.2041 (Tubular heat exchangers for use in the petroleum industry) have been taken into account wherever applicable. The standard covers cylindrical shell and plain tube heat exchangers for general applications within size ranges of 6in to 42in for nominal shell diameters, of 6ft to 16ft for tube lengths and of ¾in to 1¼in for tube diameters. The following types of heat exchanger are included: fixed tube plate (non-removable tube bundle), "U"-tube (removable tube bundle) and floating head (removable tube bundle). Because a wide range of heat exchangers exists, more sizes have been listed than desirable in a standard. Industry is asked to encourage the use of those sizes asterisked as being preferred so that eventually it should be possible to cut out the other sizes.

WHEEL PAIRS FOR LOCOMOTIVES AND ROLLING STOCK (DIMENSIONS). PART 3: TYRES

No. 3117 : Part 3 : 1961. Price 4s. 6d. This specification gives preferred leading dimensions and contours for finish-machined, rough-machined and as-rolled locomotive, carriage and wagon tyres suitable for wheel centres conforming to Part 2 of B.S. 3117. A list of preferred sizes for diameter on tread, internal diameter, thickness and width is included. Tolerances necessary for the satisfactory fitting of the tyre on the wheel centre are given. The publication of this standard completes the set of British Standards for components of wheel pairs for locomotives and rolling stock. Part 1 for axles, Part 2 for wheel centres and monobloc wheels, Part 4 for the Gibson ring type fastening and Part 5 for machining and assembly have already been issued.

GALVANISED STEEL WIRE FOR ARMOURING SUBMARINE CABLES

No. 1441 : 1961. Price 4s. 6d. Whereas the old edition of B.S. 1441 dealt only with galvanised high-tensile steel wire, the new edition covers four classes of galvanised steel round wire in sizes ranging from 0·340 to 0·083in diameter for armouring submarine cables. Classes covered are as follows: mild steel wire, tensile range 24 tons to 32 tons per square inch; mild steel wire, tensile range 29 tons to 36 tons per square inch; medium tensile steel wire, tensile range 42 tons to 52 tons per square inch; and high-tensile steel wire in tensile ranges of 60 tons to 70 tons per square inch, 70 tons to 80 tons per square inch, 80 tons to 90 tons per square inch and 95 tons to 110 tons per square inch. Methods of test, test requirements and tolerances are specified, and details are provided relating to the various sizes for each class and tensile range of wire, selection of test samples, retests, galvanising, packing and identification.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Thurs., June 22.—SOUTH LONDON BRANCH: Greyhound Hotel, High Street, Croydon, Surrey, "Public Supply Distribution," 8 p.m.

Fri., June 23.—SOUTHAMPTON BRANCH: Day visit to the G.E.C. Research Laboratories, Wembley, 8.30 a.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., to Sun., July 5 *to* 9.—1961 Convention: Christ Church, The University, Oxford, "Radio Techniques and Space Research."

INSTITUTE OF NAVIGATION

Wed., June 21.—Visit to National Maritime Museum, Greenwich, 2 p.m.

INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY

To-day, June 16.—APPLIED SPECTROSCOPY GROUP—MANCHESTER AND DISTRICT BRANCH: Literary and Philosophical Society Lecture Hall, George Street, Manchester, "Spectroscopic Studies Using Time Resolution Techniques," 10.30 a.m.

INSTITUTE OF SEWAGE PURIFICATION

Mon. to Fri., June 19 *to* 23.—Annual Conference at Brighton.

INSTITUTION OF CIVIL ENGINEERS

Wed., June 21.—Great George Street, Westminster, London, S.W.1, Conversazione, 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Tues. to Thurs., June 20 *to* 22.—SOUTH MIDLAND CENTRE: Diamond Jubilee Celebrations with visits to the North Staffs Sub-Centre, Rugby Sub-Centre and to the Main Centre in Birmingham.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., June 17.—SOUTHERN BRANCH: Visit to Godmersham Pumping Station, Mid-Kent Water Company, Canterbury, 10.30 a.m.

Sat., June 24.—SOUTHERN BRANCH: Visit to Brighton Corporation Water Department, Church Street, Brighton, and to Mile Oak Pumping Station, 2.15 p.m.

INSTITUTION OF MINING ENGINEERS

Wed. to Fri., July 19 *to* 21.—The University, Nottingham, Summer Meeting. *Wed., July* 19.—Great Hall, Trent Building, The University, Nottingham, General Meeting, 11 a.m. and 2.30 p.m.

NATIONAL PHYSICAL LABORATORY

Mon. to Wed., June 26 *to* 28.—National Physical Laboratory, Teddington, Middlesex, Three-day conference on "The Control of Noise."

PLASTICS INSTITUTE

Mon. and Tues., June 19 *and* 20.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Conference on "Education and Training in the Plastics Industry."

Advanced Engineering Courses

Current Practice in Fuel Efficiency. NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE, SOUTH WESTERN AREA, Ailsa House, 181, King's Road, Reading. Eighth annual refresher course to be held at The Clarendon Laboratory, Oxford, from September 25 to 29. The course covers a wide range of subjects and presents an opportunity for works managers, works and plant engineers, and technical staff of industrial, municipal and public undertakings to acquire up-to-date information on developments and research into the more efficient use of fuels, plant and processing. Fee, covering course, accommodation and meals, £16 16s.

Statistical Quality Control and Acceptance Sampling. THE COLLEGE OF ADVANCED TECHNOLOGY, Birmingham. A full-time course of three weeks' duration commencing Monday, September 11. The course is primarily intended as an introduction to the subject, but nevertheless provides the basic training necessary for quality control engineers. The first fortnight will be spent in covering the general principles and procedures of quality control. The final week will be devoted to lectures by specialists from industry, and to visiting the works of firms employing quality control, where members of the course will be able to see the practical application of quality control methods, and discuss the techniques and associated problems.

BOROUGH POLYTECHNIC, Borough Road, London, S.E.1. **Modern Developments in Non-destructive Testing of Metals.** A course of six lectures, given by specialists from industry on consecutive Wednesday evenings at 7 p.m., commencing October 4. Fee 10s. Type of student: metallurgists, engineers and others interested in this field.

Refractories, their Manufacture, Properties and Uses. A course of ten lectures, given by L. R. Barrett, A.R.I.C., M.Inst.F., F.Inst.Ceram., on consecutive Friday evenings at 7 p.m., commencing October 6. Fee £1. Type of student: metallurgists, chemists, engineers and others engaged on work involving the use of refractory materials.

Recent Advances in Semi-Conductor Metallurgy. A course of six lectures given by A. S. Abrahams, A.I.M., on consecutive Tuesday evenings at 7 p.m., commencing October 24. Fee £1. Type of student: metallurgists, physicists, electrical engineers and others engaged on research and development work in this field.

Corrosion and Protection of Buried Metals. A course of six lectures, given by specialists from industry on consecutive Thursday evenings at 7 p.m., commencing November 2. Fee 10s. Type of student: metallurgists chemists, civil engineers and others engaged on work in this field.